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BEFORE THE ARIZONA CORPORATION COMMISSION

COMMISSIONERS

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2009 DEC 31 P 4: 37
AZ CORP COMMISSION
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IN THE MATTER OF THE APPLICATION OF SULPHUR SPRINGS VALLEY ELECTRIC COOPERATIVE, INC. FOR A HEARING TO DETERMINE THE FAIR VALUE OF ITS PROPERTY FOR RATEMAKING PURPOSES, TO FIX A JUST AND REASONABLE RETURN THEREON, TO APPROVE RATES DESIGNED TO DEVELOP SUCH RETURN AND FOR RELATED APPROVALS.

DOCKET NO. E-01575A-08-0328

NOTICE OF FILING INDEPENDENT FEASIBILITY STUDY IN COMPLIANCE WITH DECISION NO. 71274

On September 8, 2009, the Arizona Corporation Commission issued Decision No. 71272 ("Decision") in the above-captioned matter. The Decision requires that Sulphur Springs Valley Electric Cooperative, Inc. ("SSVEC"), as a matter of compliance, docket by December 31, 2009, a feasibility study prepared by an independent third party that includes alternatives that could mitigate the need for construction of SSVEC's proposed 69 kV project.[1]

In compliance with the Decision, SSVEC hereby files the independent feasibility study prepared by Navigant Consulting, Inc.

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Arizona Corporation Commission
DOCKETED
DEC 31 2009
DOCKETED BY

[1] Decision at page 48, lines 16-20.

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RESPECTFULLY SUBMITTED this 31st day of December, 2009.

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NAVIGANT
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Independent Feasibility Study of Electric Supply Alternatives

Prepared for:

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Willcox, Arizona

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December 2009

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Executive Summary

This report presents the result of an independent investigation performed by Navigant Consulting, Inc. (NCI) of feeder performance and supply options for customers served by Sulphur Springs Valley Electric Cooperatives, Inc.'s (SSVEC) V-7 distribution feeder and Huachuca substation. The investigation responds to a mandate outlined in an Arizona Corporation Commission (ACC) Order dated August 17, 2009.[1] Our analysis assesses existing feeder performance and the capability of the existing system to serve current and future electric demand. It includes identification of potentially feasible alternatives to mitigate current performance issues and to identify solutions to serve customers over the next 20 years.

All findings presented herein were prepared independently, without bias or prior knowledge of feeder performance issues or concerns raised by customers and other interested parties. Methods employed to evaluate performance and supply alternatives are consistent with common utility practices and applicable industry design, performance and evaluation standards. The analysis was completed without direct or indirect participation or input from SSVEC staff, management or its customers.[2] Solutions considered include a broad range of electric delivery, demand-side management, distributed generation and renewable energy options. However, these options were limited to commercially available mature technologies versus those which have not advanced beyond pilot or demonstration phases.

The V-7 feeder serves over 2400 electric meters along 360 miles of lines, and is well above the average line length of other SSVEC feeders. Reliability performance as measured by total outages and duration is inferior to other SSVEC feeders. Table ES - 1 presents average outage hours per customer for the last ten years. However, the large majority of these outages affected less than three to five customers, and these were caused mostly by lightning and animal-related events. While outage rates are high, NCI does not view current feeder outage performance to be unusual for a line with the distance and exposure of the V-7 feeder; among other factors, the remote service territory requires crews to travel longer distances to restore service, which increases average consumer outage duration.

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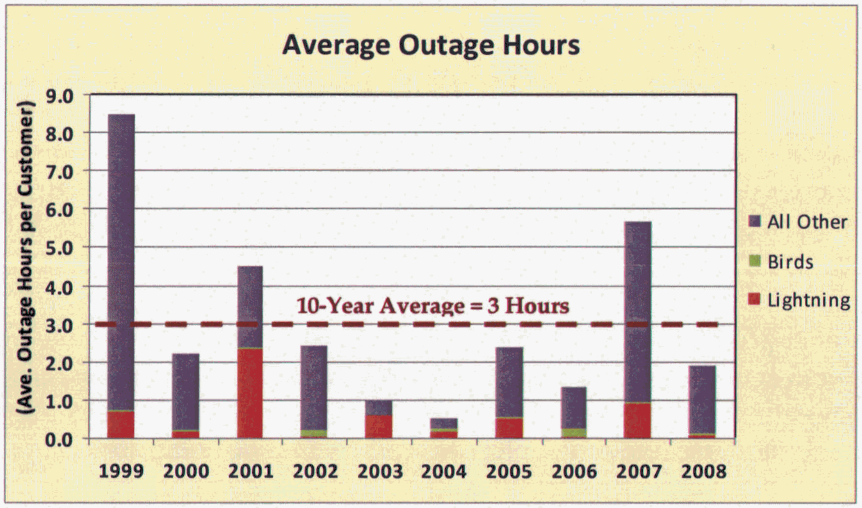
[1] The section of the ACC's Order that governs the conduct of NCI's study is summarized in the following excerpt: "Sulphur Springs Valley Electric Cooperative, Inc. as a matter compliance, shall docket by December 31, 2009, a feasibility study prepared by an independent third party that includes alternatives (including use of distributed renewable energy) that could mitigate the need for construction of Sulphur Springs Valley Electric Cooperative, Inc.'s proposed 69kV project."

[2] An independent engineering and consulting firm, TRC Solutions, was engaged by SSVEC to respond to information and data requests submitted by NCI.

Table ES - 1: Average Outage Hours per Customer



Reliability performance as measured by the number of outages and duration has modestly improved, as SSVEC has implemented measures to mitigate lightning, animal and weather-related events. Notably, full feeder outages that interrupt all customers served by the V-7 feeder have been very low – less than one per year over the last five years. The low number of full feeder outages and effective use of reclosing circuit breakers along many sections of the V-7 feeder has limited the average outage hours per customer to about three hours. New supply alternatives which reduce line exposure by creating new feeder segments would improve reliability by 15 to 30 percent beyond current levels. However, the number of momentary interruptions would likely decrease by a much larger percentage.

Feeder voltage regulation has been impacted by growing loads on a long feeder that experiences significant voltage drop. Several voltage regulators operating in tandem are necessary to maintain voltages within acceptable levels. Voltages vary considerably between off- and on-peak loads, and regulating devices must be carefully set and checked to avoid unacceptably high or low voltages. There is evidence that very high voltages may be caused by electrical anomalies that occur under light loading conditions, or on longer line sections equipped with several voltage regulating devices operating in series.

Resolution of voltage anomalies were beyond the scope of this effort, but should be addressed if the V-7 feeder remains in its current configuration. (Voltage perturbation may continue to be a problem even if certain upgrades outlined herein are implemented.) The long lines also create power quality events – mostly voltage sags – characteristic of long lines where fault current is low, especially for faults occurring on outlying line sections. Further, our studies reveal that full coordination of protective devices may be difficult to achieve due to line-end fault currents that approach normal phase trip settings.

From its investigation, NCI offers the following:

> *The results of **NCI's** investigation indicates SSVEC should take immediate action to address current performance issues and capacity limits, including carefully assessing the impact of customer requests for new or expanded service on V-7 feeder performance and capacity.*

The historic feeder peak demand *excluding line losses* was approximately 5650 kilowatts (kW) in February 2008; the cost of supplying these losses is estimated at $230,000 annually. The V-7 customer peak is expected to increase to about 8000kW by 2029, above the Huachuca substation and V-7 feeder ratings of approximately 7000kW; line and equipment losses will increase total loading to about 9000kW - the adjustment for losses will depend on which supply option is selected. Several alternatives were considered to meet current and future demand, including demand management (which includes energy efficiency), renewable energy, distributed generation and upgrades to the power delivery system. Up to 20 solutions were considered, including construction options previously evaluated by SSVEC. A screening analysis eliminated options that did not meet technical, environmental and economic criterion.

Notably, several options considered resulted in line loss savings of 500 kW or greater. The significance of this finding is that relatively small amounts of demand management and judiciously placed generation results in net effective generation of up to 150 percent of the nameplate rating of the alternative For example, installation of 2000 kW of generation in the Sonoita area results in a net load reduction of well over 2500 kW as measured at the Huachuca substation. Similarly, transmission supply alternatives reduce peak losses by over 500kW, which would significantly reduce the $230,000 annual cost of supplying these losses.

Candidate solutions were screened to eliminate those which were not technically mature or commercially available, or which did not provide a long-term solution. Alternatives that were deemed to be feasible to meet feeder and substation demand over 20 years include:

- New 69 kilovolt (kV) transmission supply – along the San Ignacio Del Babocomari Ranch (SIDB or Ranch);
- New 69kV transmission supply – along State Route (SR) 82 and Elgin Road;
- Distributed generation – diesel units located at the proposed Sonoita substation site;
- Fuel switching – conversion of electric heating to another fuel to reduce winter peaks; and
- Demand management – electric storage heating to reduce winter peak loads.

These alternatives were analyzed from a technical, economic, and environmental perspective. From an economic perspective, distributed generation (DG) and demand reduction in the form of electric heating conversion produced the lowest cost. However, use of diesel generators burning fossil fuels would produce local emissions in Sonoita and likely would require a permit from the Arizona Department of Environmental Quality (ADEQ).

Table ES - 2 summarizes the results of the economic comparison studies of those options deemed to be most feasible. Results indicate reduction in peak electric heating use produces the lowest costs when evaluated over 20 years. Reduction in electric heating use assumes a significant number of SSVEC customers would agree to permanently convert existing electric heating systems to alternate systems such as modular propane units or electric storage heating; a comprehensive appliance survey would be needed to confirm electric space heating load during feeder peaks.

Table ES - 2: Economic Comparison of Alternatives

Alternative	Capital Investment	Fuel and O&M Cost	Line Loss Savings	Total NPV
New 69kV to Sonoita: Along SIDB Ranch	$13,424	$231	$879	$ 12,776
New 69kV to Sonoita: Along SR 82	$17,004	$288	$879	$16,413
Diesel Generation	$2,277	$3,892	$418	$5,751
Electric Heating Conversion	$1,386	$1,428	$460	$2,355
Electric Storage Heating	$1,788	$ 350	$77	$2,061

Although economic results appear favorable, the viability of electric heating options is at best uncertain, as the level of incentive and marketing efforts would be sufficient to motivate customers is unknown. The willingness of customers to remove existing heating systems and replace them with alternate systems has not been established. Further, there is uncertainty as to whether there are a sufficient number of eligible heating systems to reliably meet feeder demand and mitigate performance issues. For example, customers with heat pump systems would not be candidates for conversion. Further, both DG and fuel switching options do not materially reduce momentary interruptions and voltages sags, nor do they address power quality issues; including those created by high load imbalances and possible circuit resonance.

All 69kV transmission options provide robust capacity support over 20 years (and longer), and improve power quality and feeder performance. The investigation of environmental issues indicates the new 69kV line along new and existing rights-of-way along the SIBD has the greatest impact of the options considered. The 69kV options have the greatest visual impact with modest impacts from a biological and cultural perspective. Most visual impacts are in the Sonoita Hills subdivision and a three-mile portion of SR 83 that transects the SIDB. Options to mitigate visual impacts include low-profile vertical construction and use of poles that blend with the landscape. These mitigation efforts lessen the visual impact of the poles and wires, and give the line an appearance similar to typical distribution lines, but with heights of 10 to 15 feet above those of typical distribution lines.

Most renewable energy options, including wind and solar photovoltaic, did not provide sufficient coincident peak load reduction to be feasible – the feeder peak occurs during cold winter mornings when the sun is low on the horizon. Concentrated solar power (CSP) could provide a solution, but would be very large, expensive and have potentially undesirable visual impacts; it also requires significant land, which may be difficult to obtain in quantities sufficient to construct devices large enough to reduce peak demand. Energy storage systems show much promise and efforts are underway on a national scale to advance the technology and reduce cost, but are still in the early stages of development – the limited number of suppliers and long lead times for systems that are technically viable precluded energy storage from further consideration. Storage also would require complex monitoring and control schemes to ensure sufficient storage was available and dispatched in a manner that will reduce loads over the full duration of the daily peak.

It is important to note that DG, energy storage and CSP options may be riskier than distribution or transmission options, as each would need to be available when called upon to reduce feeder demand. Several smaller units would need to be installed in the event one or more units were out of service or otherwise unavailable to operate; for example, due to forced outages or inability to start. Further, special operating procedures, and communications and control equipment would be needed in the events these devices are tripped due to momentary operations of reclosing circuit breakers. Although fuel switching and fossil-fuel DG options could meet future demand, possibly up to 20 years, neither would not fully mitigate voltage sags and or materially reduce the number of momentary interruptions. The cost to improve reliability and mitigate performance issues would be in addition to the cost of the conversions or DG options.[3]

The electromagnetic field (EMF) levels associated with existing lines versus options considered indicate each of the proposed upgrades or load management options will likely produce lower EMF levels than existing facilities. However, there are no published standards or findings of health impacts either from the State of Arizona or federal agencies. Accordingly, NCI is not able to offer an opinion on the relative merits of each option on the basis of EMF levels.

The preferred alternative based on feeder performance and firm capacity requirements is the construction of new 69kV line along the Ranch where SSVEC has easement rights.

[3] The cost of mitigating reliability and performance issues were beyond the scope of the feasibility study.

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Project Background

This study was prepared in response to an Arizona Corporation Commission (ACC) order dated August 17, 2009 that directed Sulphur Springs Valley Electric Cooperative (SSVEC) to engage a third party to investigate "alternatives [including use of distributed renewable energy] that could mitigate the need for construction of SSVEC's proposed 69kV project" and to submit its findings to the Commission by December 31, 2009. The results of this investigation will be available to the general public in forums to be held over six months in the impacted communities.

Background

To support existing and future loads and address operating deficiencies along a 24.9 kilovolt (kV) distribution circuit that includes nearly 360 miles of three-phase and single-phase primary line, SSVEC recently proposed construction of approximately 24 miles of new 69kV transmission lines and a new 10/12/14MVA, 69/24.9kV substation to be located in Sonoita, Arizona. The new Sonoita Substation would reconfigure the V-7 feeder into four separate 24.9kV feeders from the existing overhead distribution lines located near the new substation site. A fifth feeder breaker is proposed for the new substation to serve as an injection point for future distributed generation (DG) resources. Members of local communities have expressed concerns about the need for and the construction of the new 69kV transmission line and the 69/24.9kV substation, and formally raised these concerns to both SSVEC and the ACC.

Scope and Objectives

The purpose of the Sonoita Reliability Project (SRP) Feasibility Study is to independently evaluate the operational performance and to identify deficiencies on SSVEC's 24.9kV V-7 distribution circuit at current and forecast peak load levels, and to identify and evaluate options to mitigate performance deficiencies. The study does not attempt to rebut or support previous studies, findings or recommendations. All options and alternatives considered for mitigation of operational deficiencies include only mature, commercially available technologies. All potential options must provide a long term solution to correct deficiencies, evaluated over a 20-year project life. The evaluation includes an assessment of potentially feasible alternatives from a technical, economic and environmental perspective.

To accomplish the above, Navigant Consulting Inc. (NCI) was engaged by SSVEC to perform the following tasks:

1. Evaluate the operational performance of 24.9kV distribution circuits.
2. Evaluate the operational performance of 69kV-24.9kV distribution substations.
3. Identify the root causes of substation, distribution circuit and transmission line operational deficiencies.
4. Conduct distribution feeder and area load growth studies.
5. Identify and evaluate mature, commercially available distributed renewable energy technologies as potential options for mitigating distribution circuit and substation performance deficiencies.
6. Evaluate the selection of 69kV-24.9kV distribution substation site options.
7. Evaluate 24.9kV distribution line upgrade and new construction options.
8. Evaluate potential environmental impacts of 69kV transmission line route options.
9. Prepare cost estimates and comparisons of DG, renewable energy, and line construction of alternatives to resolve distribution feeder and substation operational deficiencies.
10. Evaluate the potential environmental impacts of line construction and DG alternatives.

Methodology

The approach NCI employed to evaluate options includes a thorough technical, economic and environmental assessment of potentially feasible alternatives. It includes a projection of need for additional feeder and substation capacity, an operational and condition assessment of existing facilities, and a reliability and performance assessment of the V-7 feeder. Both demand and supply-side options are considered, and potentially viable alternatives are compared from a technical, economic and environmental perspective. Viable alternatives include technologies deemed as mature and commercially available (as viewed by those involved in or responsible for electric utility power supply and energy delivery planning and operations). Alternatives that are in the demonstration phase or where equipment has limited availability due to technology limitations or absence of reputable suppliers were not considered.

Most technical, cost and economic assumptions in the feasibility study are based on data acquired from SSVEC, field observations and inspections, and an independent review of available records. Where existing SSVEC data was used, NCI independently reviewed it for reasonableness, and introduced new data and analyses where none existed or was insufficient to develop findings. The analysis includes an independent technical assessment based on current industry practices, experience with similar facilities, and conformance with Rural Utility Services (RUS) planning, design and reliability criteria. NCI did not directly contact or meet with SSVEC personnel at any time during the study, and all data and information requests were submitted to TRC Solutions, an independent engineering and consulting firm familiar with SSVEC's service territory and electric delivery facilities.[4]

From the independent evaluation, we identified options that SSVEC could pursue to ensure a reliable and dependable supply of electricity is maintained to SSVEC customers in the near and long-term. All options or combination of alternatives deemed to be technically viable are compared over a 20-year horizon using present worth economic evaluation methods. For each option, the relative merits and trade-offs of reliability, environmental, rights-of-way and other factors are presented and quantified. Our analysis recognizes that SSVEC will conduct public review meetings. Accordingly, our findings include actions that should be considered to ensure reliability is not compromised and sufficient capacity is available to meet feeder and substation peak loads during 2010.

[4] An SSVEC employee accompanied NCI and TRC Solutions personnel during site and line routing inspections, including access to the Babocamari Ranch. However, NCI did not request data or seek opinions on the feasibility or viability of proposed reinforcement or expansion options during our inspection.

Assessment of Existing Electric Delivery System

The existing V-7 feeder and Huachuca substation were analyzed to identify current deficiencies. Deficiencies may include line and equipment overloads, violation of steady state voltage limits, sub par reliability performance, operational inefficiency and inadequate line protection. To evaluate feeder performance, NCI conducted load flow studies utilizing Milsoft's Windmil engineering simulation model.[5] Other sources and data used to evaluate performance include feeder outage statistics, applicable design standards and planning criteria, and other SSVEC reports detailing prior performance issues. Where applicable, NCI reviewed databases, engineering studies, and other documents for accuracy and applicability. However, all NCI studies were conducted independently without direct input or recommendations from SSVEC engineering, operation or planning personnel. All methods employed to evaluate the existing system (and applicable supply options) conform to current utility and general RUS practices, including simulation methods and standards used to evaluate feeder performance.

Description of Electric Supply and V-7 Feeder

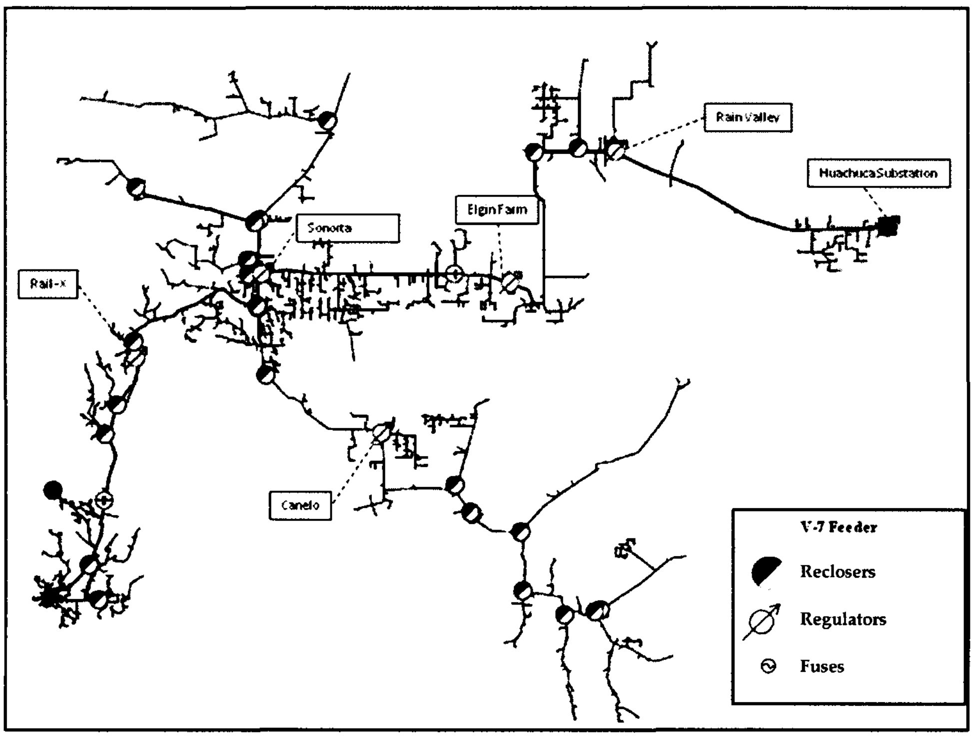
The V-7 feeder is served from SSVEC's Huachuca substation near the intersection of State Routes (SR) 90 and 82 in the town of Whetstone. The Huachuca substation includes two transformers, one rated 69/12.47kV that serves load south and east of the substation; the other transformer is a 69/24.9kV unit rated 7 megavolt amperes (MVa). The two transformers often are referred to as Huachuca East and Huachuca West, respectively. The only circuit fed from the 69/24.9kV transformer is the 24.9kV V-7 feeder. The V-7 feeder serves the furthermost western section of SSVEC's service territory. There are no feeder tie lines backing up any primary lines or lateral taps on the V-7 circuit.

The total length of V-7 is over 350 miles, the longest among SSVEC's feeders. The higher voltage of the V-7 feeder – most of SSVEC's distribution system operates at 12.47kV - is essential in order to maintain voltages within acceptable levels. The V-7 feeder includes approximately 53.1 miles of three-phase lines, 1.6 miles of two-phase lines, and 275.6 miles of single phase distribution. A simplified one-line diagram of the V-7 feeder is displayed in Figure 1. The feeder does not have right-of-way easements, but grandfathered under prescriptive rights. These prescriptive rights allow SSVEC to perpetually operate and maintain these feeder segments, but prohibit material changes to the physical or electrical attributes of the line. The

[5] NCI utilized Windmil data bases provided by SSVEC; including line impedances, nodal loads, and other devices located on the V-7 feeder. NCI reviewed model databases and calibrated the model to match actual loads and to confirm actual line performance.

feeder serves about 2400 electric meters or about seven meters per line mile; low, but not uncommon for a rural feeder serving mostly residential and small commercial load.

Figure 1: V-7 Feeder Diagram

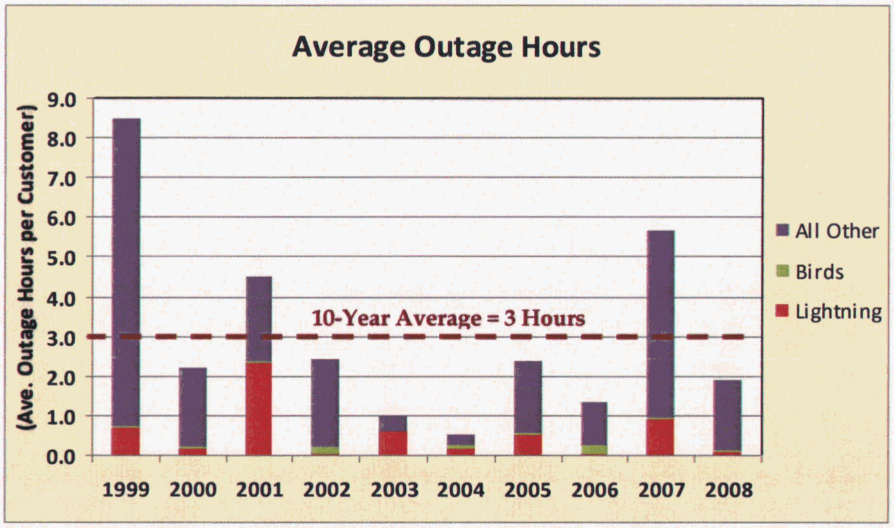


Reliability Performance

For over 10 years SSVEC has collected outage statistics, including the number of sustained outages by cause, duration, and number of customers affected, among other data.[6] (NCI used the SSVEC data without modification to derive each of the reliability charts that follow.) One of the more common statistics utilities collect is the total time that customers are out of service, measured in minutes or hours. Figure 2 presents annual customer outage hours, which over 10 years has averaged three hours per customer. While high, the duration is not unusual for very long feeders; the value drops to 2.4 hours if 1999 is excluded (in 1999 several wind-related events interrupted all customers served by the feeder).

[6] Sustained outages typical are those that interrupt service for more than five minutes; outages less than five minutes are classified as momentary interruptions by the Institute of Electrical and Electronic Engineers (IEEE), although some utilities apply a lower time threshold.

Figure 2: Annual Average Outage Hours per Customer



In addition to the above chart, NCI also assessed reliability performance using other common indices that measure interruptions at the system level, often referred to as SAIFI (average frequency of interruptions per customer), SAIDI (average duration of interruptions per customer), and CAIDI (average duration of interruption per customer). Results are for the V-7 feeder summarized in Table 1.[7] Similar to other utilities, the annual values can vary dramatically, often due to changes in the number of severe weather events.

Table 1: V-7 Reliability Indices

Year	SAIFI	SAIDI	CAIDI
1999	1.5	8.9	5.9
2000	0.9	2.2	2.6
2001	2.8	4.5	1.6
2002	1.5	2.3	1.5
2003	0.5	0.9	2.0
2004	0.3	0.5	1.8
2005	1.8	3.0	1.6
2006	0.3	1.1	3.9
2007	1.5	4.8	3.2
2008	1.3	1.6	1.3

[7] The SAIDI index is very similar to the charts that summarize consumer outage hours; the number of customers is used to derive SAIDI and other indices presented above.

Figure 3 presents the annual outages on the V-7 feeder over the last 10 years. Although the number of outages is higher than more compact feeders with fewer feeder miles, the number does not appear inordinately high given the very rural area served and significant outage exposure. Subsequent tables indicate that many V-7 outages affect only one or a few customers. Further, many of these customers are located in remote areas, which mean crews often have to travel long distances to restore service.

Figure 3: Total Annual Outages

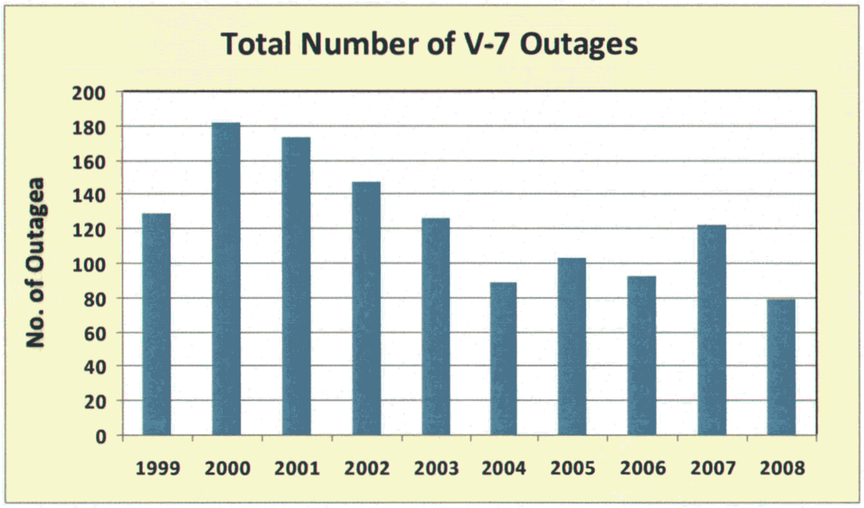
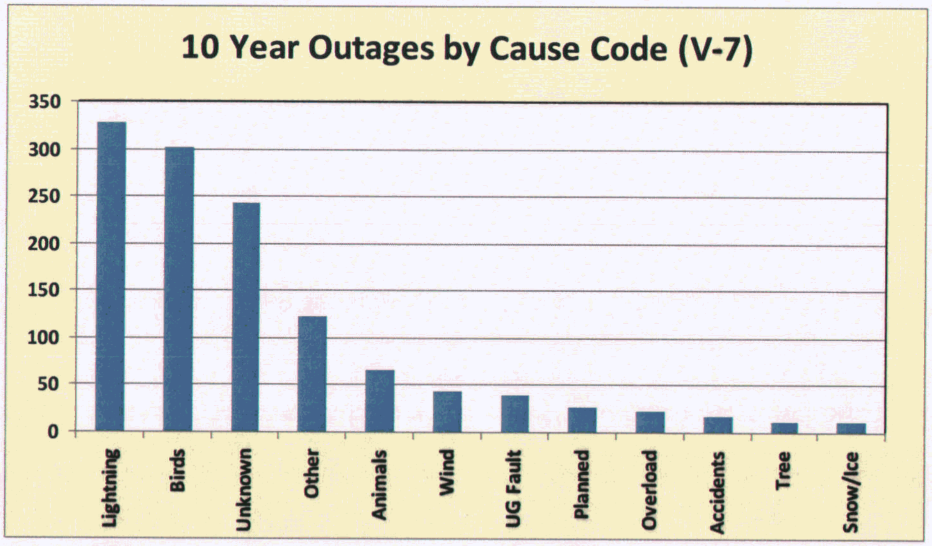


Figure 4 presents composite 10-year outages by cause code for the V-7 feeder. The primary causes of outages have been weather (lightning, wind) and animals (birds, other animals). Other dominant outage causes include unknown and other, many of which could be weather or animal-related, but otherwise not observed by field personnel or customer who reported the outage.

Figure 4: V-7 Feeder Outages by Cause Code



The average number of customers is presented in Figure 5, which indicates the majority of outages only impact fewer than five customers. Also, very few outages interrupted all customers served by V-7.

Figure 5: Number of Consumers Affected per Outage

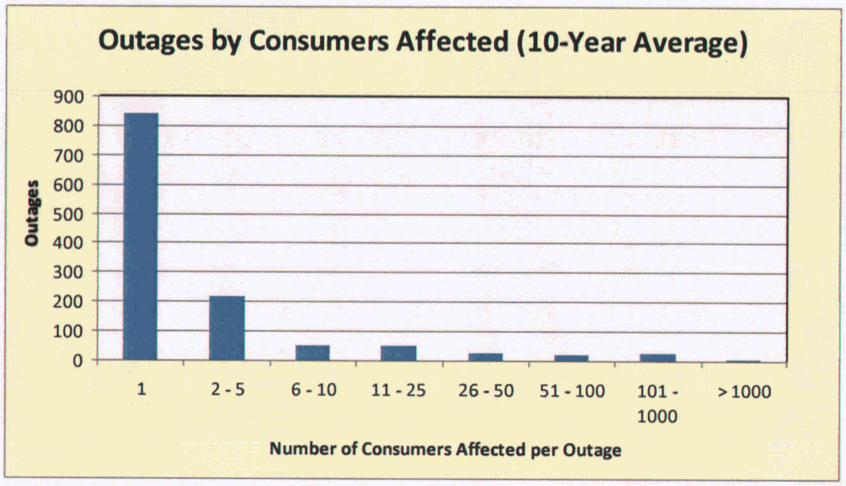


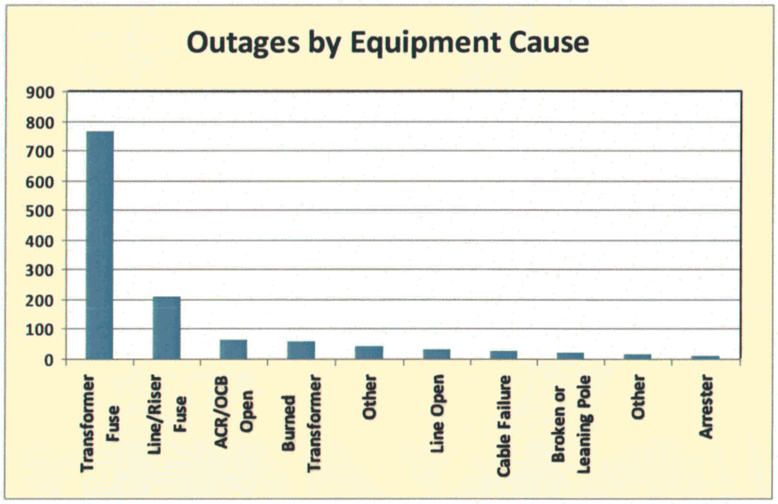
Figure 5 indicates the majority of outages only interrupted a single customer; over 90 percent of the outages interrupted three or fewer customers. These results conform to data from Figure 6, which indicate most outages are due to transformer or pole riser fuses, many of which serve one or a few homes. (The very large lot sizes limit the number of secondary services that can be served by a single transformer: if the distance between the line transformer and service entrance is over 300 feet, it may create unacceptable voltage drop.)

The low number of full feeder outages and effective use of reclosing circuit breakers along many sections of the V-7 feeder has limited the average outage hours per customer to about three hours. New supply alternatives which reduce line exposure by creating new feeder segments would improve reliability by 15 to 30 percent beyond current levels. However, the number of momentary interruptions would likely decrease by a much larger percentage.

The equipment that caused the outage or that was the interrupting device is presented in Figure 6. The large majority of outages were caused when line or transformer fuses opened. Interestingly, the large number of transformer fuse operations is an unexpected finding, as most animal and lighting-related outages occur on the primary line; whereas transformer fuses typically open when a fault occurs on the secondary side of the line transformer.

It is possible transformer fuses may be opening due to high in-rush currents following recloser operations or because of high voltage potential rise across fused cutouts.[8] However, NCI did not independently research this phenomenon to confirm a relationship between recloser trips and fuse cutout operations.

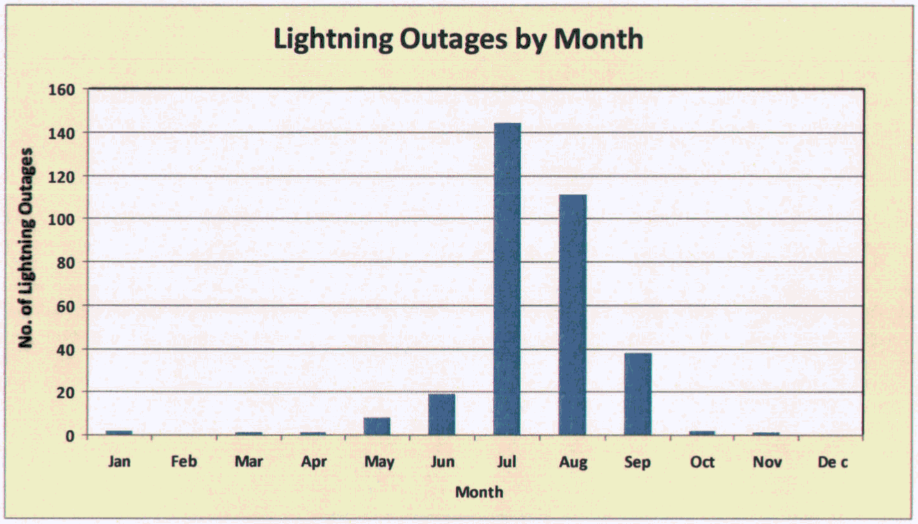
Figure 6: V-7 Feeder Outages by Equipment Cause



[8] SSVEC's standard for line transformer arrester placement is adjacent to the fuse cutout. Industry research suggests the preferred placement for arresters is directly on the transformer to reduce voltage potential rise on the transformer leads.

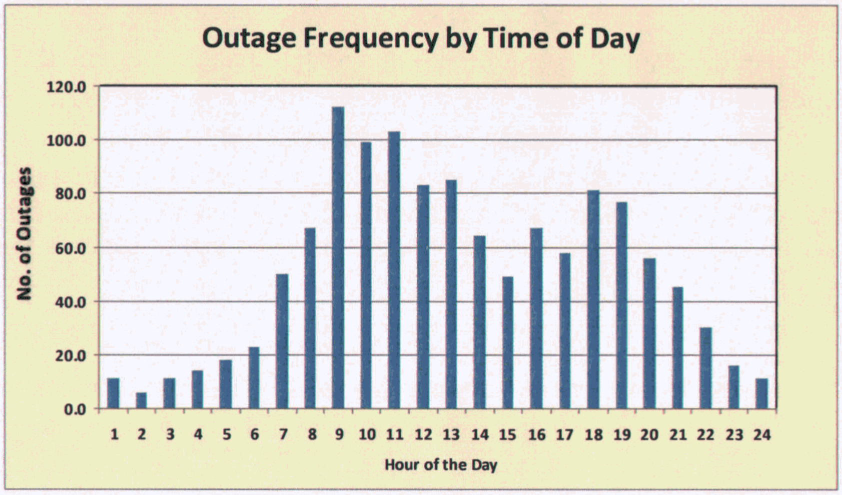
Figure 7 confirms that lightning-related outages, the largest single cause of outages, occur primarily during the summer months. SSVEC may be able to reduce restoration times for outages caused by lightning by supplementing crews or coverage times beyond current levels for summer months only.

Figure 7: Lighting-Related Outages by Month



Similarly, as shown in Figure 8, outage frequency listed by time of day reveals many outages occur during morning hours or late afternoon/early evening hours when crews have just started or ended the work day. Supplementing crews or extending coverage during these hours in months of high outage frequency, if SSVEC has not already implemented such measures, may prove cost effective for reducing outage duration on the V-7 feeder.

Figure 8: Outage Frequency by Time of Day



Equipment Condition

During its inspection of the V-7 circuit, NCI did not see significant or unusual levels of deterioration of lines or substation equipment. The substation appears reasonably well-maintained with proper clearances and absence of ground scrub, bird nests or rusting. Many new poles appeared to have been installed on several sections of the V-7 circuit. Records indicate SSVEC has replaced many poles and installed lightning protection along many miles of line. Our field observations support these records. Many sections of V-7 have overhead shield wires and regularly spaced arresters on highly exposed sections of lines. Typical V-7 construction is shown on Figure 9. Further, SSVEC has installed animal guards on many transformers, devices and equipment leads. Each of these measures is appropriate given the high incidence of lightning and animal related outages. They also appear to have been effective, given the decline in number of outages over the past 10 years.

Figure 9: Typical V-7 Construction

Historic reliability data also support a finding that outages caused by equipment deterioration have modestly declined over the past 10 years. Notably, the incidence of wind-related outages appears to have declined, most likely due to SSVEC's pole replacement program. SSVEC has proactively replaced deteriorated poles along several miles of line in the past several years. Similarly, installation of lightning and animal protection measures appeared to have had a favorable impact on feeder reliability. Nonetheless, the continued high incidence of lightning related outages suggests targeted improvements such as installation of additional arresters, improving ground resistance and installing overhead shield wires may need to be expanded beyond current levels.

From the above, NCI concludes that feeder and substation facilities are generally in good condition and appropriately maintained. Our findings regarding the need for capacity support generally is independent of feeder and substation equipment condition.

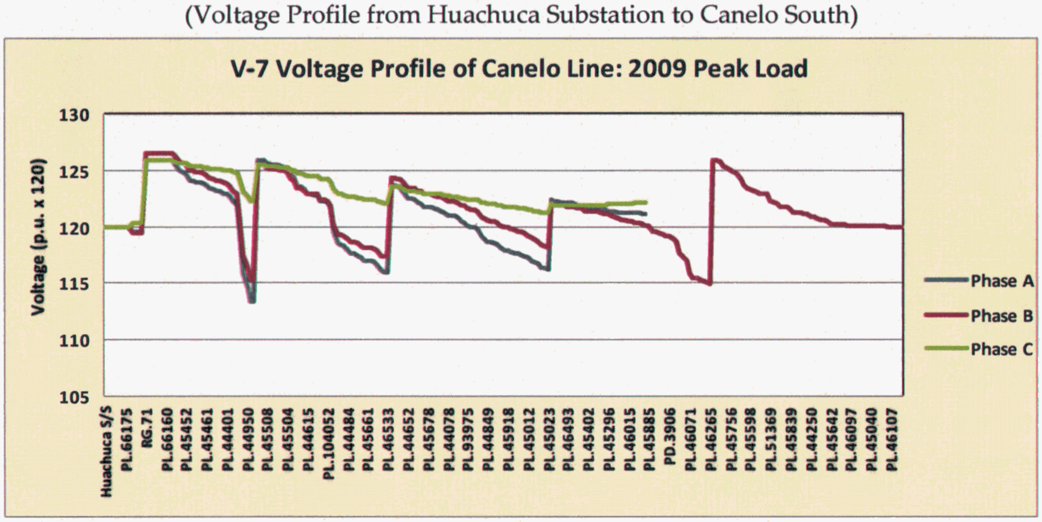
Feeder Voltage Performance

NCI examined steady state feeder voltage performance under light and heavy load conditions. Utilities with long feeders often find upgrades are needed to maintain voltages within prescribed limits as loads increase. The Milsoft Windmil simulation model was used to predict feeder voltage performance. Model data bases, including lines impedances, nodal loads, transformer ratings and impedances, construction types, device characteristics and ratings, substation devices, and power factor were provided by SSVEC. NCI reviewed the data for reasonableness, but did not make any adjustments to the data base; except for future **years'** studies, where all loads were increased proportionally according to projected load growth. The base case Windmil studies generally confirmed actual loads measured at the Huachuca substation. However, as noted later, the model was not able to predict localized high voltage readings measured by field meters, which appear to be due to non-linear loads or resonance that the model is not designed to calculate.

Figure 10 illustrates the V-7 feeder voltage profile at peak for the segment of line orginating at the Huachuca substation to the end of the southernmost section of the single phase lateral tap line passing through Canelo and south of the San Ignacio Del Babocomari Ranch (SIDB or Ranch). Each segment where voltages increase to 126 volts (or similarly high levels) is where voltages regulators are installed. Although significant regulation is needed to maintain voltages, model results predict that they are within acceptable levels.

Figure 10: V-7 Feeder Voltage at Peak (Canelo)

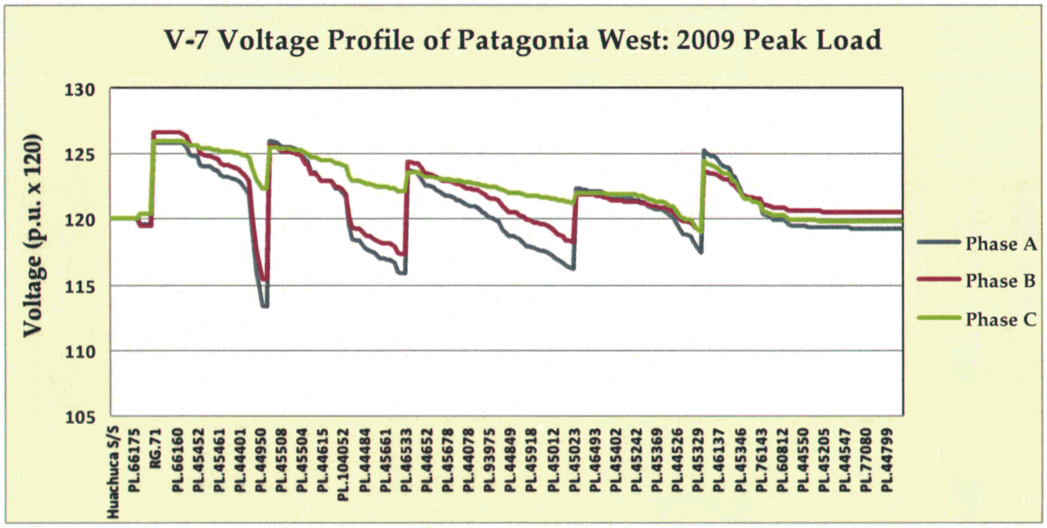
(Voltage Profile from Huachuca Substation to Canelo South)



Similar to line segments to the south, similar sawtooth voltage patterns appear on the line segment originating at Huachuca and extended to the end of the feeder in Patagonia (Figure 11). Other line segments are predicted to follow patterns similar to those presented in these illustrations.

Figure 11: V-7 Feeder Voltage at Peak (Patagonia)

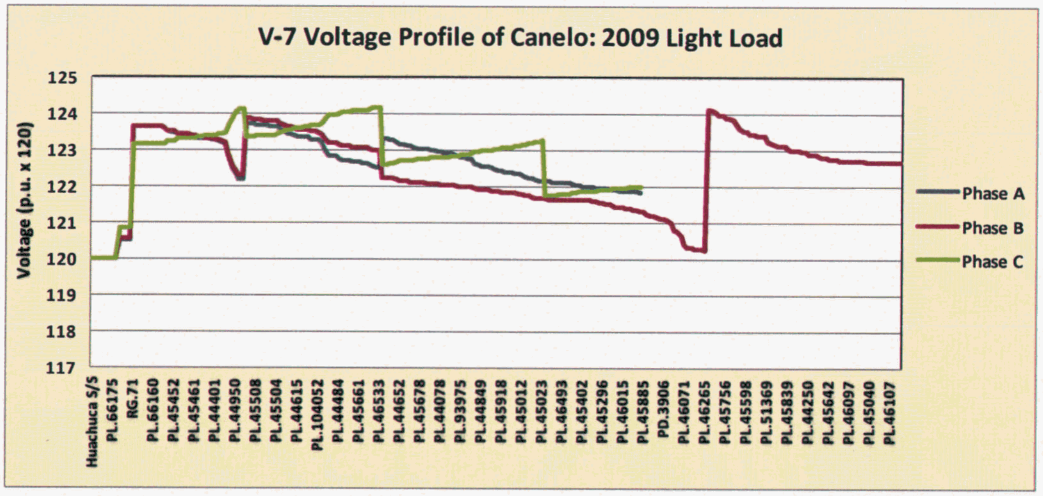
(Voltage Profile from Huachuca Substation to Patagonia)



Each of these diagrams confirm that significant amount of feeder regulation is needed to maintain voltages within prescribed standards (i.e., minimum service voltage of 114 volts). Notably, up to 10 percent boost is needed at several regulator locations. As shown on Figure 12, under light load conditions feeder voltages still vary, but to a lesser extent. The Windmil simulation model reveals that large load imbalances causes individual phase regulation to vary significantly, particularly Phase B is a very long section of single-phase line serving Canelo and areas south of the Ranch.

Figure 12: V-7 Feeder Voltage under Light Loads (Canelo)

(Voltage Profile from Huachuca Substation to Canelo South)



Notably, predicted voltages from the Windmil model *do not* match actual voltages that SSVEC has recorded for over a year. Metered phase voltages recorded in February 2009 reveal voltages over 130 volts on several occasions. Exhibit 1 illustrates the range of voltages recorded via three-hour intervals over the entire month. These voltages are well above industry standards and can potentially harm customer-owned equipment. It is possible that harmonic current and circuit resonance issues may be causing the voltage anomalies[9] - these need to be resolved for whichever long-term option is selected.

Feeder Protection

The length and high impedance of the V-7 feeder presents significant feeder protection challenges, as line-end outages produce fault currents at the Huachuca station approaching phase trip settings. This phenomenon is common for very long circuits, where the impedance of the line from the point of fault to the substation breaker is high. Further, low fault currents can cause difficulties in coordinating recloser and fuse protection. Lastly, the lower fault current can degrade power quality, as the clearing times for reclosers or fuse links is longer compared to shorter feeders with higher fault currents.

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[9] The time and effort needed to independently conduct controlled measurement studies at different locations on the V-7 feeder was beyond the scope of the feasibility study. NCI understands that SSVEC is currently conducting such measurements. Further, Milsoft, the supplier of the Windmil engineering simulation model used for the feasibility study, indicated the model does not simulate the impact of resonance and harmonics.

One of the advantages of new supply options (substation) located centrally along the existing V-7 feeder is the corresponding increase in available fault current. The higher fault current allows protective devices to operate faster, thereby improving power quality and protection coordination. Protection coordination also is facilitated by the fewer number of protection zones, achieved by creating several independent feeders, each with independent substation feeder breakers – four were proposed for the new 69/24.9kV Sonoita Substation, with one spare for future use or to connect DG.

In addition to protection coordination challenges, the very long length of the V-7 feeder can cause temporary high loads following an outage of a main line section of the V-7 feeder, complicating restoration efforts. Following an outage, customer equipment including appliances and space heating will simultaneously energize, causing high in-rush currents and the potential for utility line and equipment overloads – commonly referred to as cold load pick-up. The temporary overloads are compounded if pre-outage loads are high, as high incremental line losses combined with cold load pick-up can cause loads to be well above normal.[10]

As noted, heavy phase imbalances currently exist on the V-7 feeder, which creates high neutral currents. This imbalance requires higher setting for ground protection relays, effectively de-sensitizing these relays.

In addition to sustained outages, momentary outages that clear via line or substation reclosers also can disrupt customer loads, particularly sensitive electronic devices. Because of the very long length of V-7, SSVEC has installed many line reclosers to limit the number of customers impacted for outages along the feeder main line and lateral tap lines. Outage records indicate these reclosers have been effective at limiting the number of customers impacted by lateral and main line outages. Table 2 lists the number of substation and line recloser operations on the V-7 feeder over the past six years. Each recloser operation either causes a momentary or sustained interruption to V-7 customers.

[10] A compelling example of this phenomena is confirmed in an outage that occurred on December 8, 2009; where the substation breaker locked out, causing an interruption of service to all V-7 customers. Because the outage occurred under high load conditions (temperatures in the **40's)**, cold load pick-up caused load as measured at the Huachuca substation to exceed 8000 kilovolt amperes (kVa), well above the transformer rating of 7000 kVa and near the trip setting of phase conductors.

Table 2: V-7 Recloser Operation

Year	Huachuca Substation No. of Recloser Operations	Huachuca Substation No. of Recloser Lock-Outs	Line Devices No. of Recloser Operations	Line Devices No. of Recloser Lock-Outs
2004	402	4	26	0
2005	137	9	33	0
2006	145	6	46	0
2007	266	18	17	1
2008	147	9	5	0
2009	202	10	4	2
Totals	**1299**	**39**	**138**	**3**

These reclosers have successfully limited the number of full feeder lock-outs, thereby improving reliability. However, customers on other line section likely have experienced voltage dips due to the length of time needed to clear permanent faults. Further, the successful reclosing of the Huachuca substation breakers nonetheless causes a momentary interruption to all customers served by the V-7 feeder.

Power Quality

As noted in prior sections, steady state voltages can vary significantly due to rapid changes in load. Voltage dips caused by recloser or fuse operation can cause voltages to temporarily drop to low levels; particularly for customers located on sections of line far from the Huachuca station or on long tap lines.[11] Absent a new supply source that will strengthen voltages in outlying areas, voltage dips and perturbations are likely to continue, and worsen as loads increase. As noted in other sections, high line losses under high load conditions exacerbate voltage drop.

Harmonics and Resonance

There appears to be some evidence of potential resonance or harmonic performance issues (Exhibit 1), these conditions have not been confirmed or independently verified. SSVEC has measured voltages at several locations on the system, some of which indicate the presence of voltage anomalies, which may be caused by non-linear harmonic currents or system resonance.

[11] Momentary interruptions less than five minutes are not considered power quality events, except to the extent customers on adjacent lines encounter voltage dips. IEEE 1366 differentiates power quality events from momentary outages. Power quality events include voltage dips, harmonics, voltage flicker and other waveform anomalies; but exclude interruptions, including those which are momentary; i.e., those less than 5 minutes in duration.

Additional measurements and study is needed to confirm the conditions under which these occur on the V-7 feeder[12]

Poor power quality with the presence of harmonics can affect nearly every element within a power system via thermal and mechanical stresses. These stresses result in additional power losses and reduction in the overall equipment life span to utility and customer equipment. For example, magnetic devices such as motors, transformers or relay coils operating under harmonic conditions experience large thermal losses that can result in high levels of heat which can reduce the overall structural integrity of the device.

Other known affects of the presence of harmonic distortion is caused by telephone interference and faulty metering results. The telephone interference is causes by the harmonic electromagnetic field (EMF) coupling with the transmitted telephone signal. Faulty meter results could occur in the presence of harmonics unless the meter is designed with true-RMS sensing. If the metering device is designed with only peak or average RMS sensing ability then faulty voltage readings could occur from the presence of the non-linear waveform caused by the harmonic distortion.

Mitigation methods commonly used by the utilities include eliminating the system resonance blocking the harmonic source or by removing the harmonic currents of the system. These methods could be applied by feeder sectionalizing, adding or removing system capacitance, or by incorporating filters.

Harmonic Mitigation Options

In case there is a problem with harmonic distortion on the V-7 feeder there may be several options available for mitigation. Two of these methods could include either feeder separation, such as the 69kV Sonoita Substation – four feeder option or by implementing filters along the V-7 feeder. Most likely if the filters were needed, they would be shunt filters designed to mitigate harmonic frequencies observed on secondary voltages for the V-7 feeder.

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[12] System resonance is the condition when the inductive reactance of the system equals or nearly equals the capacitive reactance. When a system is in a resonant condition, the resonant currents experience minimum losses and is resisted only by the resistance of the conductor. At resonance these currents may magnify and create large abnormal voltages. Distribution systems are designed to function with some reactive impedance to avoid resonant conditions and to supply the reactive power needed by standard loads of the consumer. Harmonics refer to the voltage or current distortions propagated from consumer loads or from other known sources within the distribution system. The harmonics of a system are these voltages or currents at a frequency that is a multiple of 60 Hertz and influence the overall system reactive impedances.

A thorough assessment of the possible harmonic distortion in the V-7 feeder and possible options for mitigation are beyond the scope of this report; however it is possible the V-7 feeder experiences some levels of harmonics due to the long length of the line, number of regulators, past high voltage meter readings, and preliminary measurements made along the feeder. Two solutions that typically are applied to resolve harmonics include:

1. Locate point source of the harmonics and eliminate the source as stated above; or
2. Shorten feeder lengths to reduce total harmonic distortion (THD) on the feeder.

Absent the above, further study would be needed to determine the most effective means of implementing a method of mitigation if the problem is indeed found to exist. Industry sources and articles suggests the following when trying to make a determination as to whether tuning the circuit will mitigate the problem: Utilities should be certain to ensure the existence of harmonic sources on the power system by performing a frequency scan and harmonic resonance evaluation to avoid resonance to guarantee the benefits of applying capacitive compensation, if such measures are appropriate for the V-7 feeder.[13]

Distribution Line and Equipment Losses

Feeder load flow studies confirm that line and equipment losses impact feeder performance and the need for additional capacity. Losses include both no load and load losses. No load losses are independent of feeder load and occur mostly on substation and line transformers. Load losses include those which are a function of line loading. Because losses are proportional to the square of the load, any increase in load can significantly increase line losses, particularly on longer lines. Such is the case with the V-7 feeder, where losses at peak are approximately 30 percent of total feeder demand. Significantly, incremental losses approach 50 percent – that is, for each additional one kilowatt (kW) of load added to the feeder, on average, approximately 1.5 kW must be delivered from the Huachuca substation at peak.

The Windmil model was used to predict historic and future line losses for all supply alternatives. Losses shown below in Table 3 represent a substantial portion of the total electric demand on V-7; over 20 percent of feeder and substation capacity is consumed in losses; capacity that otherwise would be available to serve customer load. However, the losses are not unexpected or unusual, as the length of the line causes losses to be much higher than shorter feeders. Notably, the higher voltage of the line, 24.9kV, produces losses that would otherwise

[13] SSVEC recently recorded voltage and current harmonic distortion levels at several points along the V-7 feeder. These results confirm the presence of harmonics, with total current harmonics of up to 10 percent.

be higher if lower voltage lines were to serve the same amount of load (many SSVEC feeders operate at 12.47kV).

Table 3: V-7 Peak Losses (kW)

Year	Peak Load (kW)	Peak Losses (kW)	Total Load (kW)	Percent Losses
2000	4511	715	5226	16%
2001	4856	854	5710	18%
2002	4919	881	5800	18%
2003	4440	689	5129	16%
2004	4668	777	5445	17%
2005	4787	824	5611	17%
2006	5464	1124	6588	21%
2007	5652	1248	6900	22%
2008	5655	1248	6903	22%
2009	5406	1124	6530	21%

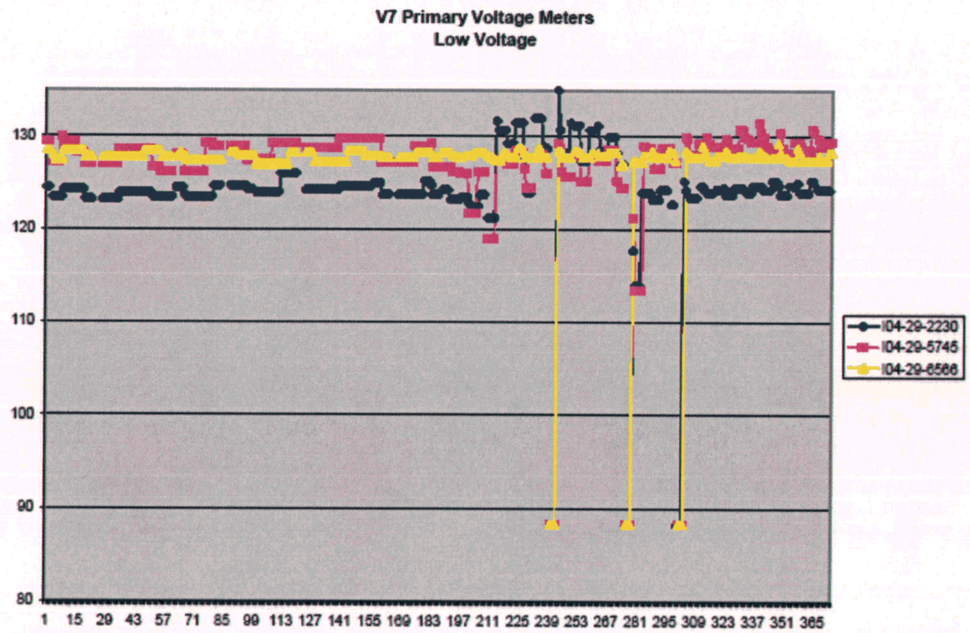
The amount of energy losses on the V-7 feeder is estimated at over 3000 megawatt hours (MWh) annually. The cost of energy and demand losses appears as additional power deliveries are paid via purchase power agreements and market purchases. The annual cost of losses is estimated at about $230,000 based on SSVEC's 2010 revenue forecast for demand and energy. A load factor of 45 percent and loss factor of 27 percent was derived by applying standard loss factors using 2008 hourly load data.[14] The costs associated with V-7 line and equipment losses are shown in Table 4.

Table 4: V-7 Line & Equipment Losses

Category	Peak Losses (kW)	Energy Losses (MWh)
Line Losses	1024	1063
No Load Equipment Losses	224	1962
Total Losses	1248	3026
Avoided Cost	$81.36/kW	$42.55/MWh
Cost of Losses	$101,539	$128,739
	Total	**$230,279**

[14] The loss factor is estimated by the equation Loss Factor = LF2* CF1 + LF*CF2; where LF equals load factor, CF1 is a coefficient usually set to 0.3, and CF2 is a coefficient usually set to 0.7.

Exhibit 1: V-7 Metered Voltages by Phase



This is a graph of low voltages seen during the month of Feb 2009 approximately every 2hrs 45min. The voltage meters record the peak and low voltage recorded between data reads, which is approximately every 2hrs 45mins. Values below 90V are usually outages.

Electric Consumption and Demand Forecast

Historic feeder and demand profiles are analyzed and the V-7 20-year load forecast is presented in this section. The contribution of line and equipment losses to V-7 peak feeder demand is also calculated to highlight the unadjusted customer load contribution to peak demand, and to provide base line data for developing a 20-year feeder demand forecast. The impact of high line losses has a significant impact on the timing of upgrades to address feeder and substation capacity deficits.

V-7 Feeder Customer and Demand

The Huachuca substation and V-7 feeder loads and load patterns are evaluated in the following subsections. It includes an analysis of historical load patterns, load growth, customer attributes, and a forecast of V-7 peak demand. Existing and future feeder peak demands are normalized to account for line losses and weather, where applicable.

Historic Electric Demand and Consumer Statistics

Table 5 presents the number of customers, listed by rate codes, served by the V-7 feeder. Notably, the largest number of customers are residential and non-demand single-phase small commercial, which reflect the rural character and low load density of V-7. Less than 10 percent are billed for demand, and of these, few take service under the Large Power rate code.

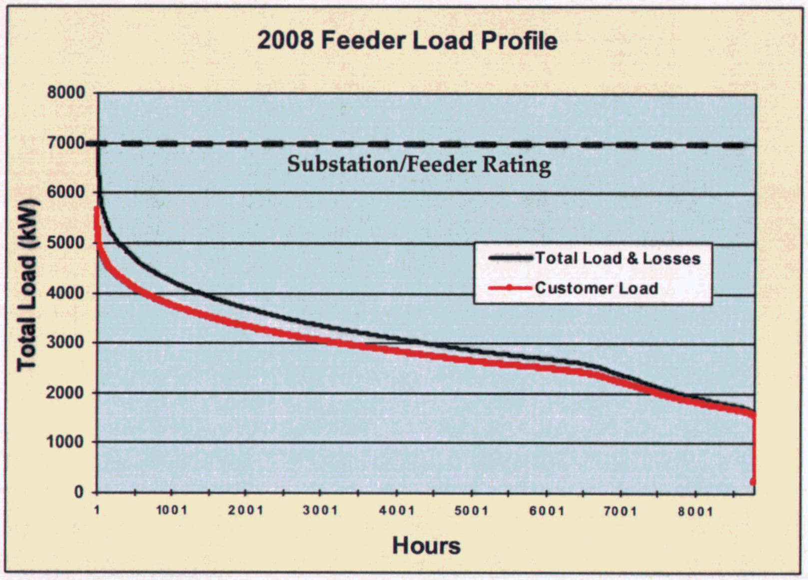
Table 5: Number of V-7 Customers by Rate Code

Rate Code	Rate Description
GS DEMAND 1-PHASE	67
GS DEMAND 3-PHASE	31
GS NON-DEMAND 1-PHASE	536
GS NON-DMD 3-PHASE	8
IRR CONTROL/W	2
IRR LOAD FACTOR DMD	1
IRR SEASONAL	1
LARGE POWER	8
LINE EXTENSION	3
PRE-METER CONST MIN	1
RESIDENTIAL	1675
RESIDENTIAL SUNWATTS	13
RESIDENTIAL TOU ON-PEAK	1
SET-UP RATE	2
TOU TOTAL KWH	6
TOTAL	**2355**

Electric Demand Profiles and Capacity Limits

The feeder and substation load profiles illustrate the number of hours when total load are expected to approach or exceed equipment ratings. The load duration curves in Figure 13 compares the V-7 load profile for 2008 to the substation transformer capacity rating. Notably, the composite 2008 peak, which combines customer load plus line losses, was about 6900 kW, just under the current substation transformer rating. Of this amount, approximately 1600 kW or 30 percent of total load was consumed by line and equipment losses.

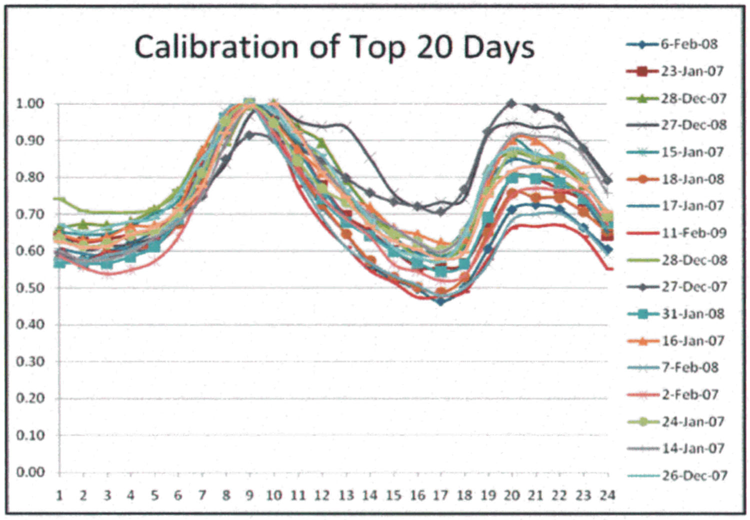
Figure 13: V-7 Annual Load Profile



The load duration curve also provides an indication of the minimum number of hours that distributed resources would need to operate (or number of hours that demand reduction would need to be enabled) to reduce load to avoid overloads or to raise line voltages to acceptable levels. For example, if the desired maximum loading limit in 2008 was set at 4500 kW, distributed resources or demand response would need to be operated or enabled for a minimum of about 500 hours.

It is also instructive to examine hourly changes in V-7 daily load profile patterns, particularly on the highest peak days when load approaches feeder capacity limits. Figure 14 presents hourly per unit load data for the 20 highest peak load days over the past three years. Aside from a few outliers or where supervisory control and data acquisition (SCADA) data appears suspect, there is high degree of comparability among the peak day load curves. This consistency likely is due to recurring heating load during colder winter days – all 20 days of highest peak load occurred during winter months. Predictable load patterns enable system planners to design programs to reduce daily peaks; e.g., targeted load reduction programs. Further, the duration of the peak hours on days with the highest demand is relatively short, as load quickly tapers off after sharp early morning peaks.

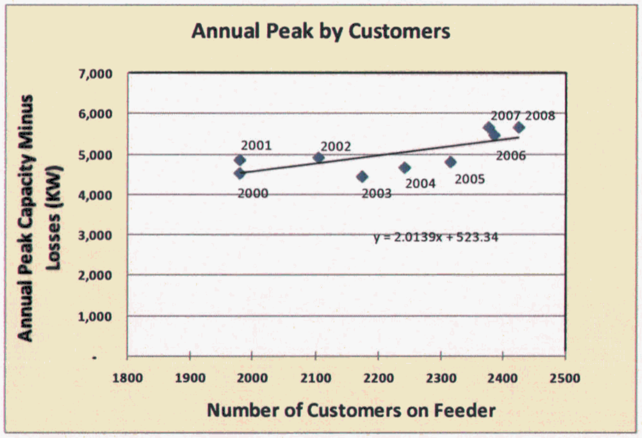
Figure 14: V-7 Peak Day Load Profile



Peak Demand Forecast

The 2008 coincident peak demand of the Huachuca substation and V-7 feeder (Huachuca West serves only a single feeder) was approximately 4.9 MVa; when line losses are added, the total feeder peak load increased to about 6.9 MVa. Over the past 10 years the V-7 feeder peak has increased, on average, 2.5 percent annually (exclusive of line losses); about the same rate as the number of customers over the same period (approximately 1900 to 2400 between 1999 and 2008). Since a linear relationship exists between historic peak capacity and the number of customers, we used customer growth projections to forecast system load growth, as shown on Figure 15.

Figure 15: Historic Feeder Annual Peak Loads

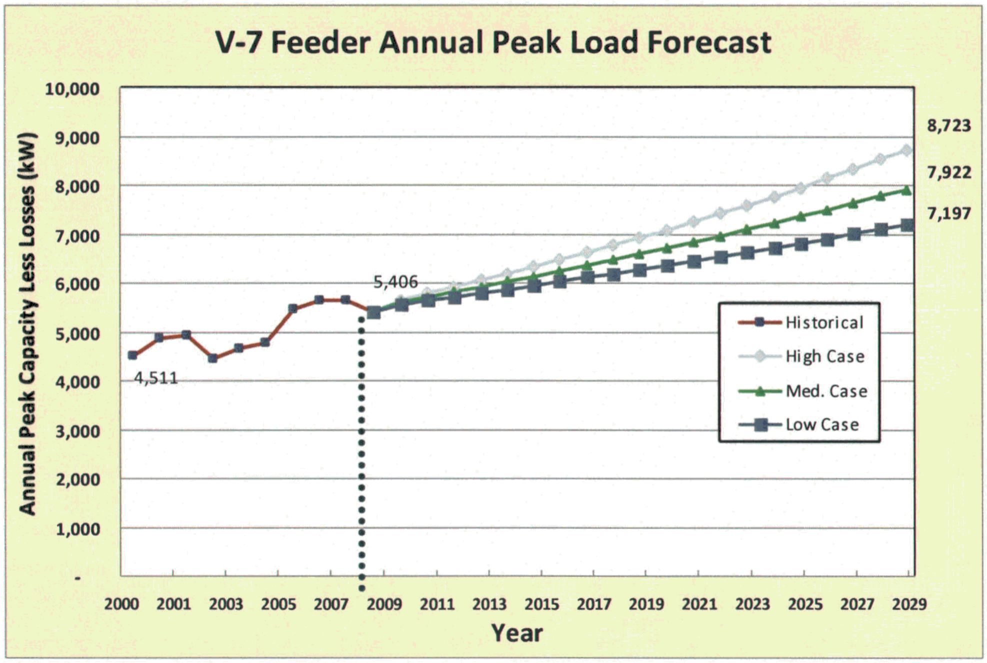


The V-7 feeder serves mostly residential and small commercial customers, with some agricultural load. The large amount of protected acreage, designated preserves and large ranching areas suggests the likelihood of additional major commercial or industrial load is low. Therefore, the customer mix by rate code, previously presented in Table 5 is not expected to vary significantly in the future. Feeder growth is likely to follow historical trends. The number of new customers added to V-7 can be used to reasonably predict increases in feeder peak loads.

County statistics from the Arizona Department of Commerce Population Statistics Unit project Santa Cruz County population growth, where mostV-7 feeder load is located, at a rate of roughly 1.8 percent over the next 20 years.[15] The increase in V-7 peak demand is expected to follow this growth pattern, but with slight adjustments to account for the rural nature of the feeder. Figure 16 illustrates the increase in peak demand for base, low and high forecasts (the base case forecast was increased to 2.0 percent to account for unknown increases and the potential for the peak load in any given year to be higher than average due to lower than normal temperatures).

[15] Arizona Department of Commerce 2006 Population Statistics projects Santa Cruz County will grow by ~1.8% from 2009-2029 (http://www.azcommerce.com/econinfo/demographics/Population%20Projections.html)

Figure 16: 20 -Year Peak Load Forecast



The high case scenario assumes the high population growth rate over the last eight years, roughly 2.5 percent per year from 2000-2008, will continue at the same rate through the next 20 years.[16] The low case forecast assumes that the growth rate will be proportionally lower (roughly 1.5 percent annual growth rate) from the base case. Using the linear relationship between customer and load growth based on historical trends and customer population projections, V-7 feeder peak load was forecast over the next 20 years as previously depicted in Figure 16.

Station Capacity

The existing 69/24.9kV Huachuca substation transformer has a nameplate rating of 7 MVa. The previous peak of over 6.9 MVa indicates virtually all available substation capacity has been used. Any significant additional load will exceed the nameplate rating of the device. Similarly, if power factors are below 1.0 per unit, the transformer will become overloaded for lower real power demand. However, utilities often adjust the rating of substation transformers based on

[16] Annual Customer Growth Rate from 2000 to 2008 for V7 Feeder= ~2.6% (see Figure 15)

ambient conditions and load patterns, and reasonable reduction of equipment life.[17] Because the V-7 feeder and Huachuca substation are winter peaking, the capacity of the transformer typically is higher than nameplate due to ambient cooling. This is in contrast to substations that peak in the summer, in which case maximum transformer loading is closer to nameplate.

NCI did not independently calculate the weather-adjusted transformer rating, but notes that other utilities often will apply rating above nameplate for devices experiencing short-duration, cold weather loading.[18] Notably, the 2008 V-7 summer peak was about 5800 kW, about 16 percent lower than the most recent winter peak of 6903 kW. Hence, an additional 1000kW of substation transformer capacity would be available at Huachuca substation if the winter rating is increased by at least 16 percent above the nameplate rating.

Projected Capacity Need

A comparison of historic and current load indicates that virtually no additional firm capacity is available from the V-7 feeder and Huachuca substation to serve future demand: the V-7 feeder appears to be the limiting element. The need for reinforcement is underscored by current feeder performance, which has very high losses, significant voltage swings, line conductor capacity, and power quality concerns. Accordingly, SSVEC should take immediate steps to ensure sufficient capacity is available to serve existing and new customers in the short and long-term. SSVEC should carefully review the impact any new load will have on feeder loading and performance to ensure voltage and loading standards are not exceeded or violated. An exception would be load that is proven to peak at times other than the current peak – these typically occur on cold winter mornings with a secondary peak during early evening hours.

The load forecast indicates about 2500 kW of new load will added to V-7 over the next 20 years *prior* to losses, an increase of about 40 percent. As noted, incremental line losses at peak are approximately 50 percent. Accordingly, supply alternatives that reduce total feeder load also reduce the percent losses on the V-7 feeder. Supply options that create a new source in Sonoita or other central locations of the feeder will cause losses to decline significantly due to the reduced loading on the primary section of line between the Huachuca substation and V-7 load

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[17] IEEE, an industry group that develops guidelines and standards for electrical equipment, has published guidelines that enable electric utilities to determine the increase in transformer rating as a function of device pre-loading, ambient temperature and expected increase in loss of equipment life. Our experience indicates winter-peaking utilities often increase transformer ratings by 25 percent (or higher) for devices in good condition. In contrast, transformers known to have operational or design constraints often are limited to nameplate capacity ratings.
[18] The determination of acceptable transformer loading is utility and location-specific. The value typically is based a combination of several factors including average ambient temperature, transformer pre-loading, transformer design, condition, performance history (including number of high current through-faults), and acceptable loss of life.

centers. If total losses are brought down to more reasonable levels of 10 to 15 percent at peak, total capacity deficits will be about 1500kW in 10 years and 3500kW in 20 years.

Supply Alternatives

Potentially viable options for meeting current and future demand for the V-7 feeder are presented below. In the Assessment of Supply Alternatives section, a screening analysis identifies options among these alternatives deemed to be technically feasible, commercially available, and capable of meeting performance and capacity requirements for 20 years. Options that meet screening criteria are then analyzed in greater detail from a technical, economic and environmental perspective.

Twenty options covering four categories of demand and supply alternatives were considered as potential solutions. These are listed in Exhibit 2, with each option designated by a two to three character code to facilitate option reference and analyses. It includes transmission and distribution options previously evaluated by SSVEC (T1, T2, T4, T5 and D4). All other construction, DG, renewable energy and demand management options presented in Exhibit 2 and described below were prepared by NCI.[19]

Supply-side options include expanding or adding new line or substation capacity, whereas demand-side options include conservation and demand-side management (DSM). We also investigate the implications and viability of a status quo option, which assumes no additional station or feeder capacity; but relies, instead, on other mitigation measures to resolve reliability issues and free up capacity to meet future demand.

Distribution Options

Distribution options include line reinforcement and facilities operating at voltages 25kV and below; it assumes no new transmission lines or substations are installed. Reinforcement options include upgrading or modifying existing lines and facilities to mitigate performance problems and meet capacity requirements. The latter option is evaluated first among those considered.

Reinforce Existing System (D1)

This option assumes existing station and feeder capacity would be used to the extent possible to serve future load. It includes rebalancing of feeder and transformer load, improving feeder voltage regulation, reducing losses and maximizing utilization of available capacity. The reinforcement of the existing system may be combined with other supply and demand-side

[19] SSVEC previously opined on the applicable of renewable energy options, including solar; but NCI is not aware of any technical or economic analyses performed for these options.

alternatives as part of an overall solution. Further, it includes steps that can be taken to mitigate voltage regulation and power quality issues, including improved fault isolation and protection coordination.

Upgrade Existing Line (D2)

This option includes line upgrades that increase feeder capacity and improve voltage regulation by replacing conductor along main three-phase trunk lines and line taps. To the extent possible, existing poles would be re-used, with taller poles or new mid-span poles installed where needed to avoid clearance violations. It includes replacing 1/0 conductor with larger 477 aluminum conductor steel-reinforced (ACSR) wire along key three-phase line sections. Similar to reinforcement of the existing system, this option includes rebalancing, and improving voltage regulation and feeder reliability. The Huachuca West substation transformer also would need to be upgraded or replaced with a unit with a higher capacity rating (also applies to D3 below). It includes acquisition of new rights-of-way (ROW) along State Route (SR) 82 and Elgin Road where prescriptive rights prohibit SSVEC from materially upgrading existing lines.[20] Approximately 99.98 percent of the 23 miles of three-phase distribution lines are along ROW's where only prescriptive rights apply.

New Huachuca West Feeder (D3)

The addition of a new 24.9kV feeder fed from the Huachuca West substation would unload the V-7 feeder and potentially improve reliability and performance. It would require construction of a new feeder bay position at the Huachuca station and require the reconstruction of approximately 23 miles of the V-7 feeder along SR 82 and Elgin Road to operate as a double circuit line. The reconstruction would require the replacement of virtually all poles along SR 82 and the Elgin Road with poles approximately 10 to 15 feet taller than existing poles.

Figure 17 presents 69/25kV circuit construction, representative of Alternative D3. Double circuit 25kV construction would have a slightly lower profile and tighter spacing for the upper circuit. As noted above, several miles of line would require new easements as the existing line is constrained by prescriptive rights that allows SSVEC to replace existing equipment in kind (e.g., where deteriorated or damaged); but excludes upgrades for capacity or functionality.

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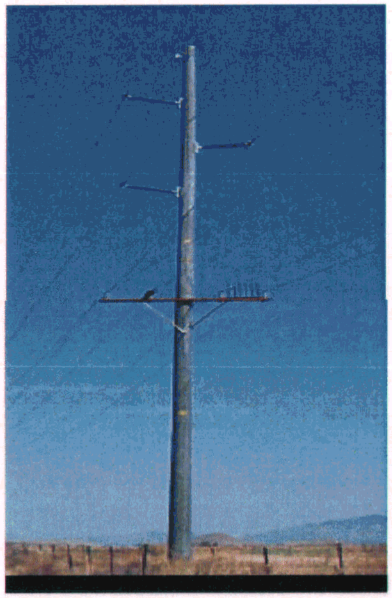
[20] Prescriptive rights apply to electric facilities where ROW easements have not been obtained, but where the facilities have been in service for a sufficiently period of time such that the utility is allowed to continue to operate the line "as is." The utility can replace deteriorated facilities in kind, but cannot increase conductor size or functionality of the line.

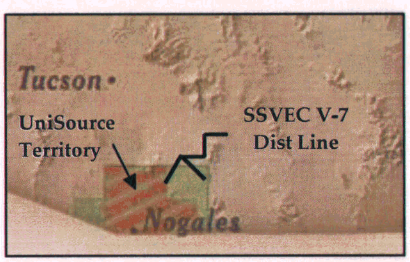
Figure 17: 69/25kV Circuit Construction



Foreign Interconnection (D4)

The segment of the V-7 line serving Patagonia extends to the western boundary of SSVEC's service territory. This segment of line also requires significant voltage boost using multiple regulators to maintain voltages within acceptable levels. Approximately two to three miles southwest along SR 82 is a 13.8 kV line owned and operated by UniSource Energy Services (UniSource). The UniSource line originates at the Valencia substation in Nogales, more than 17 miles from SSVEC's V-7 feeder serving Patagonia. If the UniSource line were extended to SSVEC's and has sufficient spare capacity at peak, it might be able to unload the Patagonia line spur to defer by several years the need to install new capacity to serve future V-7 load. The line extension would require a three-phase 13.8/24.9kV step-up transformer. Figure 13 illustrates the approximately location of the V-7 line relative to UniSource's service territory. A more detailed illustration of the location and length of the 13.8kV line extension appears in Attachment 1.

Figure 18: UniSource Electric Service Territory



Since a portion of the SSVEC load would be served by facilities owned by another utility, SSVEC would have to purchase power from UniSource, obtain transmission service from UniSource, or petition the ACC to transfer this segment of its service territory to UniSource. Further, if the latter applies, SSVEC's Board of Director's would need to approve the transfer.

Recently, SSVEC received formal notice from TEP that UES does not have sufficient capacity on the Valencia feeder to provide firm capacity on its system to serve SSVEC Patagonia load.

Static Var Compensation (D5)

Static Var Compensation (SVC) is a fast-response technology utilizing electronic controls to rapidly inject Vars into the power system to respond to reactive power deficits or voltage fluctuations caused by contingency events or rapidly changing loads; for example, those caused by the start-up of large generators on longer distribution lines. The technology also is installed on large power systems; but, smaller devices are available for application on distribution system. These devices do not provide capacity support (except in the case of network contingencies), but may be part of an overall solution, particularly if dynamic system support is needed in addition to capacity support. A typical distribution SVC is displayed in Figure 19.

Figure 19: Distribution Static VAR Compensator

Transmission Supply Options

There are several lines operating at four different voltages that cross paths with or supply the V-7 feeder:

(1) 69kV – SSVEC line that runs north-south and supplies the Huachuca substation.
(2) 46kV – Tucson Electric Power Company (TEP) line provides back-up power to Fort Huachuca Military Base.
(3) 115kV – Southwest Transmission Cooperative (SWTC) line supplies load in the Sierra Vista area.
(4) 138kV – TEP line supplies Fort Huachuca.

The capability of these lines to serve V-7 load and routing alternatives are described below. The location of each line is displayed and annotated Attachment 1.

69kV Transmission Supply (T1 & T2)

The use of 69kV transmission lines to provide a new source of supply is consistent with SSVEC's system planning and design practices – SSVEC's low-voltage transmission system is 69kV. The most appropriate location for a new 69kV substation from an electric perspective is near the physical and electric load center of the V-7 feeder. There are two vacant sites that SSVEC owns that meet this criterion; both are located within Sonoita: SSVEC refers to these as the Buchanan and Sonoita sites. Each of these sites appears in Attachment 1.

All 69kV options would originate from an existing 69kV line that serves the Huachuca substation and substations south of Huachuca. This line travels north-south and is located over 20 miles from either the Buchanan or Sonoita sites. All 69kV options are radial only, as there appears to be no basis for creating a looped or networked configuration for load located at the far western end of SSVEC's service territory, nor are there any 69kV lines that would provide a suitable source for a 69kV looped system.

From an electric standpoint, all 69kV options provide the same level of capacity and performance benefits, as the minor difference in line-miles for each options has virtually no impact on performance. Four variations of the T1 69kV Supply option are considered, the primary differences are the routing of transmission through Sonoita Hills subdivision: T1-A routing is along existing rights-of-way running parallel to the Bronco Trail Road and adjacent to the Buchanan site. T1-B assumes the line is routed along the high ridge on the eastern segment of Sonoita Hills. T1-C assumes the line is routed along SR 83. T1-D assumes the line is routed south down Papago Springs Road and west of the Buchanan site. The evaluation of 69kV alternatives focuses primarily on cost and environmental factors, as each offers near identical technical performance and reliability.

115/138kV Supply Options (T3)

There are parallel 115kV and 138kV transmission line that traverse the V-7 feeder and the Ranch that could be used to supply portions of or all load on the V-7 feeder. A new 138/25kV or 115/25kV substation could be built below the V-7 intersection along SR 82 near Whetstone, but the line is too close to the Huachuca substation to provide any meaningful support (most of the feeder is located west of the intersection). A dedicated 25kV line that would operate in parallel to the existing 24.9kV line along SR 82 and/or Elgin Road would be needed to unload the V-7 feeder.

Alternate options could include new 115kV or 138kV substations that cross the Ranch along SSVEC's existing easement. A new 69kV line would then be constructed along the easement, following the same corridor previously proposed for the Sonoita 69kV line. A new 69/25kV substation also would be needed, either at the Buchanon or Sonoita site. This option would reduce the length of new 69kV transmission along the Ranch easement by about 8-10 miles. Variations of the southern option include constructing a new 138/115/24.9kV or 138/115/69kV substation along the northern Ranch boundary. SSVEC does not have an easement along the northern border of the Ranch.

46kV Transmission Supply (T4)

TEP owns a 54-mile radial transmission line that provides back-up power to the Fort Huachuca Military base. The line diagonally traverses the V-7 feeder and Ranch (see Attachment 1). If firm transmission capacity is available and TEP agrees to provide transmission service to SSVEC[21], a new substation would be located at the intersection of the 46kV line and V-7 feeder along Elgin Road. Because a new substation would cost well over one million dollars, TEP would need to agree to provide firm capacity for at least five to 10 years to avoid a stranding of the investment – SSVEC does not own or operate any 46kV equipment; hence substation equipment would be "one-of-a-kind" and could not be used elsewhere on its system. Further, SSVEC would need to purchase spares or arrange for back-up of any equipment operating at 46kV. The intersection of TEP's 46kV line and SSVEC's V-7 feeder on the Elgin Road - where the new substation would be constructed is shown in Figure 20.

The 46kV line owned by TEP appears reasonably well-maintained; however, NCI did not review any TEP records or inspect the entire length of the line. Such a review would be recommended if SSVEC were to enter into a transmission service agreement with TEP.

[21] A minimum of 3 MW of firm capacity would be needed to unload the V-7 feeder to acceptable levels.

However, TEP recently notified SSVEC that it is unable to provide firm transmission capacity to serve SSVEC load.[22]

Figure 20: TEP 46kV Transmission Line

Underground Transmission (T5)

Underground transmission is an option that applies to any of the transmission and distribution alternatives cited above. The primary advantage of underground transmission is improved aesthetics. However, there are significant trade-offs with underground transmission: first, it is far more costly, with a cost ratio of between five and ten to one versus conventional overhead construction; second, significant excavation and trenching is needed to accommodate concrete encased duct bank systems; third, the life of underground cables generally is lower than overhead lines, and once the cables are determined to be unreliable or obsolete, the cost of replacement is extremely high compared to overhead lines. Because of the much higher cost, utilities usually will install underground transmission lines only in urban areas where overhead construction is impractical or where ROWs are unable to accommodate overhead lines.

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[22] Previously, SSVEC formally submitted a request to TEP to determine the availability of firm transmission service. While awaiting **TEP's** response, NCI investigated the viability of a new 46/24.9kV substation to serve V-7 feeder load. TEP responded late in our study that firm transmission capacity was unavailable. TEP also indicated in its response that it was precluded from providing service as it would violate **TEP's** two county bonding authority.

Demand Side Management & Incentive Rates

Demand side management includes energy efficiency, demand reduction and other measures designed to reduce load in lieu of construction of new facilities to meet capacity requirements. Historically, DSM benefits are at the power supply level and usually are not relied upon to defer construction of transmission and distribution facilities. However, a few utilities have begun to develop programs designed to defer the construction of new transmission and distribution (T&D) facilities.[23]

Targeted DSM (DS1)

An energy efficiency and distributed resource program targeted to customers located on the V-7 feeder has the potential to defer capacity upgrades if the level of firm demand reduction is coincident with the feeder peak load intervals, is sustainable over time and customers are willing to participate in the program. Customer participation typically is a function of the level of incentives provided versus the inconvenience of participation or disinterest. Our experience with similar programs indicates customer willingness to participate is perhaps the greatest challenge. The level of participation declines as the perceived cost or value of the program is diminished, or where customers are inconvenienced by program measures.

Storage Electric Heating (DS2)

Utilities for several years have marketed electric storage heating devices to reduce peak demand and energy consumption during the highest cost hours. The operating mode of these devices is straightforward. Electric storage heaters contain high density bricks or ceramics that thermally store electric heat produced during off-peak, low-cost hours. A time of use meter or timer sends a signal to the storage heating devices to ensure devices do not charge during the peak cost hours. The thermal stored energy is discharged during high cost hours via use of small internal fans that circulate and heat ambient air through small opening in the bricks to vents located on the front of the heating enclosure. Customers achieve savings by charging the heaters only during low cost hours.

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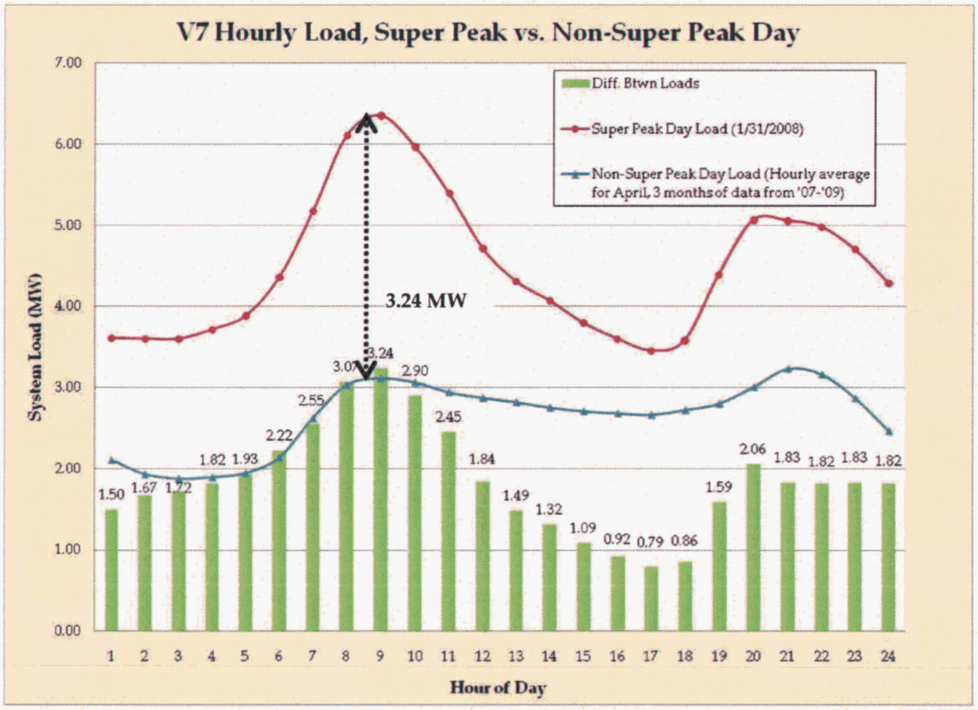
[23] For example, Consolidated Edison Company of New York recently implemented a Targeted DSM program designed to defer transmission, distribution and substation facilities. The program has been in place since 2004 and has successfully deferred some faculties. A premium is paid to contractors and customers to implement DSM measures in areas where T&D upgrades are proposed in the short **–term;** above payments made for DSM in areas of the system not subject to T&D constraints. Distributed generation qualifies for the program, but none have been installed due to timing considerations, physical assurance requirements and cost.

The amount of existing electric heating load can be estimated by comparing daily load profiles for peak winter days to non-heating days – the difference is likely due to electric heating load, with some additional peak loading created by lighting, small motor and pumping load. Figure 21 illustrates this differential, which indicates incremental loads of about 3 MW on peak load days. A portion of this load likely is eligible for conversion to storage systems.[24]

Figure 21: Peak and Off-Peak Daily Load Profile



Incentive Rate Options (DS3)

Incentive rates encourage customers to use less energy during peak cost hours or change usage patterns by shifting electric usage from high cost to low cost hours. A time-of-use (TOU) rate is established and marketed by utilities to most, if not all customer classes. The electric storage heating options described above is one form of an incentive rate option. For options that do not control usage, the price differential between the on and off peak hours must be sufficiently high to motivate customers to *significantly* reduce usage during peak hours to defer V-7 system upgrades. Currently, SSVEC offers a TOU rate with an on peak rate of about 14 cents and on off-peak rate of about 7 cents per kilowatt-hour.

[24] Customer appliance survey data is not available to identify the number of space electric heating units.

Space Heating/Fuel Switching (DS4)

The highest electric demands on the V-7 feeder occur in morning and early evening hours on the coldest winter days. Figure 14, which is provided above, presents normalized daily load shapes on the 20 days with the highest daily peak demand over the past three years. These shapes strongly suggest the peaks are driven by electric space heating. The difference in load between non-heating days strongly suggests the higher load is due to electric space heating demand. The large percentage of residential and small commercial customers (over 80 percent) served by V-7) yields average coincident heating load of 2 to 3 kW per customer. An aggressive conversion of electric heating system to propane or kerosene could reduce load during the hours of highest demand.[25] A typical direct venting modular heating unit appears in Figure 22.

Figure 22: Modular Space Heating Unit

Monitor GF 1800 Modular Propane Heating System (11,000 to 16,000 BTU)

For the program to be successful, significant conversion of existing systems would be needed over the short-term; strong incentives and an aggressive marketing campaign would be needed to reduce demand in amounts sufficient to defer system upgrades. Assuming an average of 2 kW of coincident demand and a reduction in 200kW is needed to avoid feeder overloads, about 100 customers would need to participate in the first year for this option to be viable. Each successive year would require 50 to 75 participants to offset load growth. Program costs include incentives designed to offset the cost of modular heating systems and dismantling of electric heating controls. The program could be structured similar to the targeted DSM programs described above, which includes incentives based on the value of T&D deferrals.

[25] A gas pipeline passes through Sonoita, but does not supply local distribution company (LDC) loads. NCI did not investigate use of natural gas as an alternative fuel due to the long distances needed to reach sparse, rural customers located among the many miles of line along V-7. Also, heat pump systems could be viable, but not analyzed in detail due to the higher cost of piping and venting systems. Such systems likely would be suitable for customers who are willing or able to accommodate heat pumps.

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Composite DSM/Demand Management (D5)

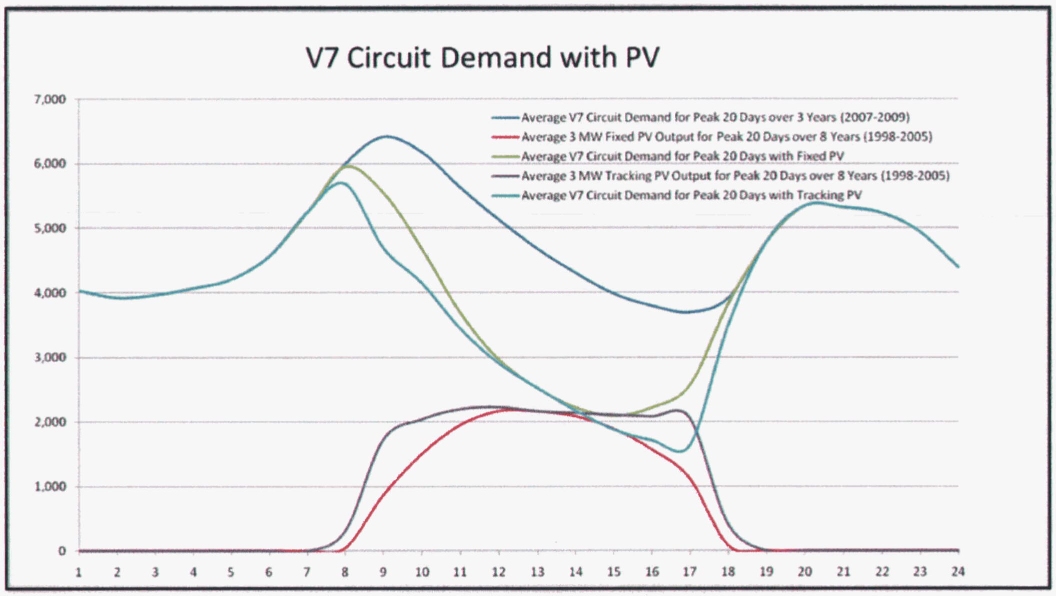
This option includes combinations of the above four alternatives, as the contribution of any single option would likely be insufficient to meet capacity deficits. For example, the amount of lighting demand may be too small to have a major impact on demand, but nonetheless may be cost-effective. When energy efficiency is combined with incentive rates and fuel conversions, there may be greater amounts of capacity reduction, and in sufficient quantities to defer capacity need dates.

Distributed Resources and Renewable Energy

Solar Photovoltaic (R1)

The high solar insolation levels in southern Arizona suggest photovoltaic (PV) could be a suitable alternative, particularly in areas where peaks occur during the hours of maximum PV output; that is, mid-day. As noted, the V-7 feeder peaks during morning and early evening hours. Figure 23 presents PV output profiles for fixed and rotating axis PV systems. There is minimal coincidence with fixed axis systems, but rotating **axis'** show higher coincidence.

Figure 23: PV Peak Day Output Profile



Eligible PV systems include rooftop and central system arrays. Because most residential rooftop systems can only accommodate fixed axis systems, central systems are likely the only feasible alternative (such systems could be customer or utility-owned). A typical 200kW PV central array is presented in Figure 24.

Figure 24: Photovoltaic (Utility Scale)

Source: Trigen web site[26]

Concentrated Solar Power (R2)

Similar to PV, the high solar insolation levels in southern Arizona suggests another promising renewable technology, Concentrated Solar Power (CSP), might be a suitable alternative to improve V-7 performance and meet capacity deficits. Concentrated Solar Power systems have been constructed in other parts of the southwest and California. One of the advantages of CSP versus PV is the ability to store thermal heat accumulated in non-peaks hours and then release the thermal energy to generate electricity when needed; e.g., to reduce peak loads. Typically, high density molten salt is used to store the thermal energy. The thermal discharge duration also is sufficiently long (several hours) to reduce feeder or substation demand during peak and shoulder hours, or when clouds intermittently appear and reduce thermal charging, a key advantage over PV systems which has no storage capability.

There are four basic CSP technologies: Parabolic Trough, Power Tower, Solar Dish and the Linear/Fresnel Lens. The Parabolic Trough is the most advanced CSP technology and the only one with commercial deployment. It is technically viable, and field performance has been proven. However, trough systems require extremely flat land (less than one percent slope). It is difficult to maintain this over a large area. Typical land requirements are five to ten acres per MW.

Figure 25 illustrates parabolic trough technology.

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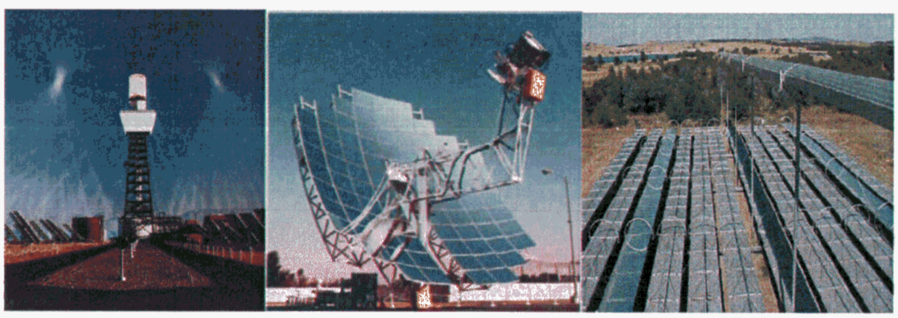
[26] IKEA AFG Arena, St. Gallen (Switzerland); Installed power 202.4 kWp.

Figure 25: Parabolic Trough

The other three CSP technologies are not commercially proven and are at the demonstration stage (see Figure 26). However, these technologies do have advantages and disadvantages when compared with trough systems.

Figure 26: CSP Technologies

Power Tower **Solar Dish** **Linear/Fresnel Lens**



The Power Tower system also requires extremely flat land (less than one percent slope) and large water intake. The two axis tracking for heliostats requires more complex controls than the **trough's** single axis system. However, higher temperature working fluid (~1000°F) than trough and Dish engines allows for higher efficiencies. Large plant sizes can allow for economies of scale to reduce costs; however, this is not as feasible for Dish engine systems.

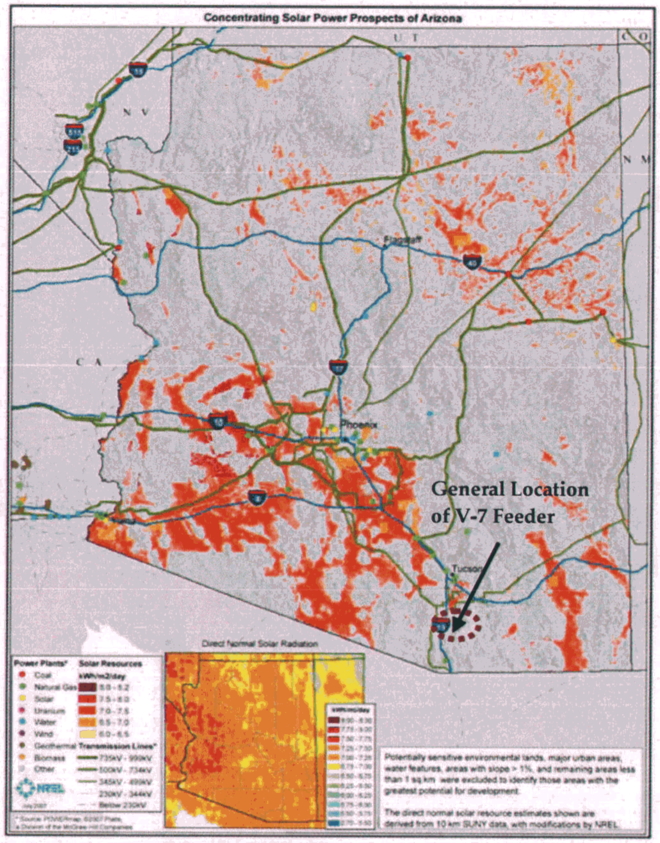
The Solar Dish system does not require extremely flat land and no water is required. However, it also requires a two axis tracking requires more complex controls than **trough's** single axis system. Initial capital costs are estimated at $6,000/kW. This is significantly higher than trough systems. Table 6 provides a technology summary for CSP systems.

Table 6: CSP Technology Summary

Issue	Parabolic Trough	Solar Dish	Power Tower	Linear Fresnel Concentrator
Technology Maturity	Market Entry	Demonstration	Demonstration	Demonstration
Current U.S. Commercial Deployment	419 MW	0 MW	0 MW	0 MW
Projects in U.S. Pipeline	Abengoa is developing a 280 MW plant with molten salt storage	Stirling Energy Systems is developing 1750 MW in So. Cal.	BrightSource has **PPA's** with PG&E & SCE	Ausra is developing a 177 MW plant in California
Driving Technology Issue	Molten salt storage has just gone commercial	Minimal performance data	Performance data and storage	Performance data and storage
Learning Curve Driver	Plant scale Installed base	Manufacturing scale up	Plant scale Installed base	Plant scale Installed base
Driving Economic Issue	LCOE higher than competing renewable and traditional technologies	Lack of commercial deployment	Lack of commercial deployment	Lack of commercial deployment

The National Renewable Energy Laboratories (NREL) have produced maps where central CSP is most desirable; that is, where average sloping is less than one percent. Figure 27 highlights the areas in Arizona where sloping can best accommodate central CSP. Notably, it appears to exclude most of the service territory fed by the V-7 feeder. A similar NREL map for areas with slopes of three percent or less show a slight increase within the service territory served by V-7 that is suitable for central CSP. There also may be local areas with favorable sloping that could accommodate smaller CSP; however, the smaller systems are less cost effective, both due to loss of economy of scale and the need to interconnect remote load via new distribution lines.

Figure 27: CSP Potential (Arizona)

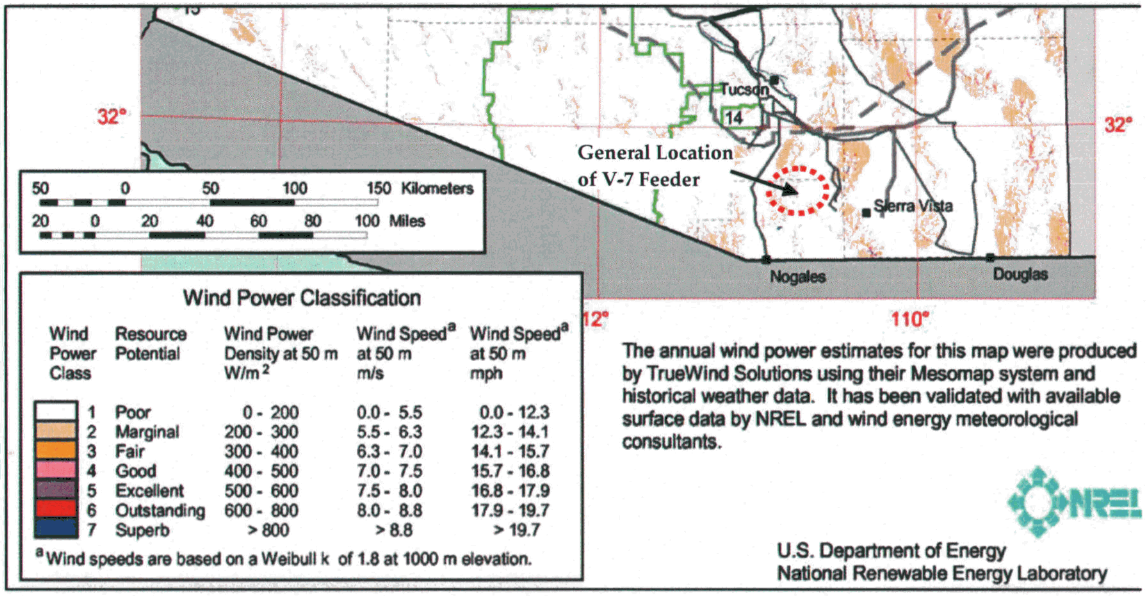


Wind Generation (R3)

Wind generation has grown considerably in areas of the U.S and worldwide with high average wind speeds and land suitable for siting wind towers. In West Texas alone, over 3000 MW of wind generation has been installed. Several large wind farms have operated for over a decade in California. Many large wind farms have been proposed in regions with high average wind profiles along coastal and mountainous regions in the eastern U.S.

As shown on Figure 28, the average wind profile for southern Arizona generally is on the lower end of the wind power classification scale, with ratings of mostly 1 and 2. Most of the V-7 feeder is located in a Class 1 area, which is defined as having poor wind resource potential. There may be pockets where local wind profiles may be higher grade, but likely insufficient to provide significant wind potential. Further, most wind projects are assigned minimal or no firm capacity credits due to the highly intermittent nature of wind – a brief drop-off in wind speed can cause unit shut-down or reduced output, with resultant loss of feeder capacity. Accordingly, NCI did not further analyze the capability of wind to reduce V-7 feeder loadings to meet current and future capacity requirements.

Figure 28: Southern Arizona Average Wind Profile



Web Source: http://www.windpoweringamerica.gov/pdfs/wind_maps/az_50m.pdf

Energy Storage (R4)

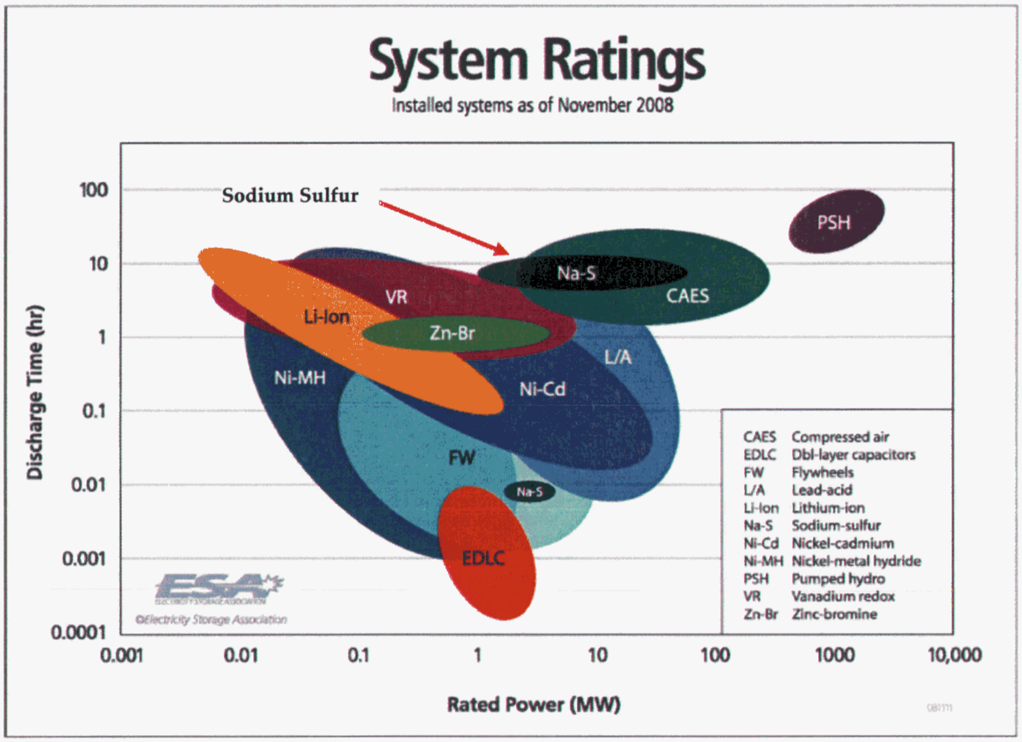
Electric energy storage systems have the potential to reduce feeder peak load by charging and storing electric energy during off-peak hours when load are low; and then discharging the device during high load, on-peak hours. Although various forms of battery storage systems have been commercially available for many years, energy storage systems of sufficient size, capability and cost for electric utility applications have only recently started to appear on utility grids; and *many of these have been pilot or demonstration projects.*[27]

Advances in battery technology have led to lower cost, more reliability and higher density battery systems suitable for utility applications, ranging from flywheel systems for fast

[27] Utilities for many decades have employed hydro-electric storage systems, commonly referred to as pumped storage hydro, to store energy via elevated ponds when energy production costs are low, and then discharging the water through hydroelectric turbine-generators during the day when prices are much higher. Most pumped storage systems are very large and designed to support the interconnected electric power grid. Pumped storage hydro is not deemed to be an option for V-7 feeder loading mitigation due to the absence of a suitable site, environmental impacts and very high cost.

response load following that can store energy for up to 15 minutes to sodium sulfur systems (NaS) that can provide continuous output for up to four (or more) hours. Lead acid (PbA) battery technology is proven, but requires frequent replacement if used for daily cycling. Lithium Ion battery systems (the technology used in cell phones, IPod's and computers) show significant promise, but are still in the pilot phase for utility application. Further, discharge durations are typically about one hour, too short to provide meaningful demand reduction. A summary of battery discharge duration interval and capacity ratings is displayed in Figure 29.

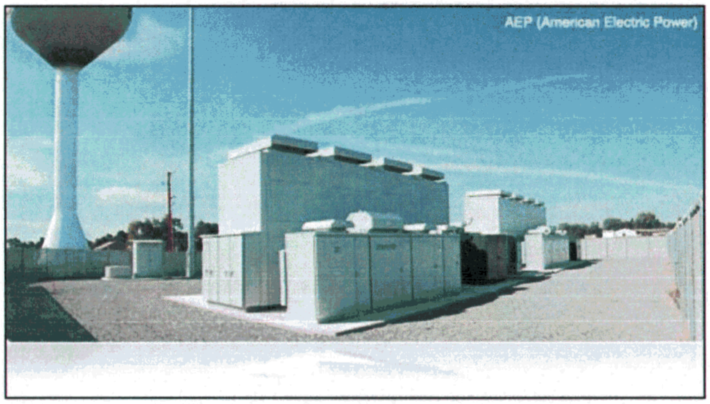
Figure 29: Energy Storage Device Attributes



Source: Energy Storage Association Web Site

Of the technologies considered, sodium sulfur appears best suited for meeting V-7 capacity needs, as the storage capacity and discharge hours conform to feeder peak load intervals. Sodium sulfur batteries have been used domestically to support or defer distribution upgrades at a cost of about $3000/kW. American Electric Power (AEP) is among the leaders in the U.S. in applying NaS to T&D systems. Utilities in Japan have successfully applied NaS systems for several years, with over 50 installations. A typical substation application appears in Figure 30. Notably, NaS battery availability currently is limited due to a high order back-log (up to one year or longer)

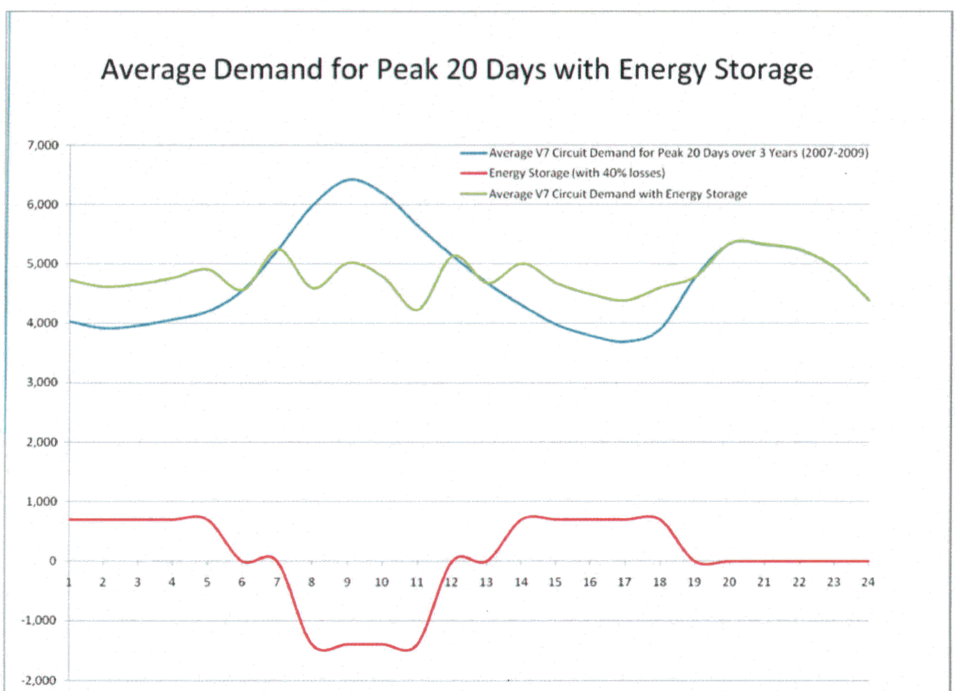
Figure 30: NaS Energy Storage System (2 MW)



Source: *NGK Insulators, Ltd*, Reference Substation Installation (AEP)

The cost of energy storage is relatively high at $3000/kW. Further, the charge and discharge profiles of energy storage devices will need to be carefully managed by automated control and communication systems that will operate these devices based on demand thresholds and devices attributes. Figure 31 illustrates a typical charge/discharge profile for the 20 days with the highest peak demand over the past three years.

Figure 31: 1000 kW NaS Energy Storage Output Profile

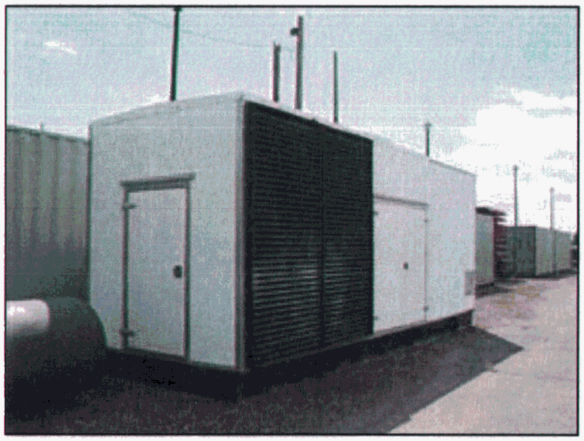


Distributed Generation (R5)

Distributed generation connected to the V-7 feeder would reduce effective loads during those hours in which it operates. The number of operating hours would be limited to the highest load hours or when it might be needed to meet feeder peak demands or stabilize voltages. Operation in a stand-alone, islanded mode is not considered, although SSVEC could consider the merits of stand-alone operation in the event of a loss of source supply from the Huachuca substation.[28]

The generator set-up would include multiple trailer or ground mounted diesel units burning low-sulfur distillate oil, or natural gas depending on the availability of local gas supply.[29] The preferred location would be the Sonoita substation site. This site is desirable for locating DG – for the same reasons as a new 69/25kV Substation - as it is centrally located (from an electrical standpoint), within a mixed light industrial/commercial area, easily screened, and on land that SSVEC currently owns. The units could readily interconnect to three-phase V-7 distribution lines located adjacent to or close to the site. A padmount transformer rated 1500 to 2500 kilovolt amperes (kVa) would be needed to step up the 480 volt output to the 24,900 volt V-7 feeder.

Figure 32: Typical 1000kW Diesel Generator



Description: Cummins 1000 kW Diesel Generator, 1503.6 Amp @ 277/480 Volt, Three Phase, 60 Hz

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[28] A stand-alone operating mode, separated from the power grid, is sometimes referred to as a Microgrid. However, operating as microgrid mode would require further study to assess feeder protection and coordination, and methods for isolating loads that otherwise could not be served by DG due to generating capability limits; that is, when load is greater than the rating of the generator.

[29] The generator would also have to meet EPA emission standards, which suppliers acknowledge in product specifications.

A fuel tank sized to hold 5000 to 10000 gallons would also be needed, with an impermeable berm or oil retention facilities capable of holding the full contents in the event of a spill. Up to four units rated 500kW each would be installed at the Sonoita site. Generator redundancy is *essential*, as it provides operating flexibility and ensures sufficient firm capacity is available in the event one of the units is out of service or does not start when called upon. Each unit would be equipped with sound enclosures to minimize disruption to nearby customers.

The technical potential of customer-owned DG, other than PV and small back-up systems (e.g., portable emergency generators), is limited. Most V-7 customers are residential and small commercial, and unlikely to install DG in amounts sufficient to reliably reduce feeder demand. Utilities that have promoted customer-owned DG to defer distribution upgrades have seen minimal acceptance and very few installations. Among other reasons, programs introduced in the U.S. have seen limited success due to a physical assurance requirement adopted by electric utilities.[30] Table 7 provides cost estimates for DG options.

Table 7: Cost Estimate – DG Options

Unit Type	Cost (2009 $Million)				
	2-500 kW Units ($000)	Site Costs ($000)	Interconnection ($000)	Total Cost ($000)	Total Cost ($/kW)
Diesel	$400	$100	$100	$600	$600
Natural Gas	$500	$100*	$100	$700	$700

* Includes cost of fencing, screening, enclosures, and oil retention facilities

[30] Physical assurance is a requirement that customers that own generation guarantee the generators will operate when needed, and agree to allow the utility to interrupt an equal amount of customer load in the event the generator is not started or unable to operate.

Exhibit 2

Supply Alternatives

Category	Alternative Description
Distribution	
D1: Reinforce Existing System	Optimize capacity and performance of existing system via load balancing, voltage regulation, power factor correction
D2: Reconductor 25kV Line (4/O to 795 ACSR)	Replace about 25 miles of conductor along SR 82 and Elgin Road from Huachuca substation to Sonoita
D3: Install New 25kV Feeder from Huachuca: Split V-7	Construct 25 miles of double circuit 25kV distribution along SR 82 and Elgin Road from Huachuca substation to Sonoita
D4: Create Tie to Foreign Source (13.8kV)	Extend UniSource 13.8kV line to Patagonia; install 13.8/24.9kV step up transformer and transfer about 1 MW of load
D5: Distribution Static Var Compensation	Install distribution class SVC at a location to be determined to improve voltage stability and power quality
Transmission	
T1: New 69kV line & Sonoita Substation on Ranch ROW	Original SSVEC proposal. Tap 69kV SSVEC transmission line south of Whetstone; construction about 25 miles of new 69kV along southern border
T2: New 69kV line & Sonoita Substation on SR 82 ROW	Construct 25 miles of double circuit 69kV transmission & 25kV distribution along SR 82 and Elgin Rd from Huachuca to Sonoita
T3: Tap 138 or 115kV Transmission Lines	Install new 138/69kV substation where 138kV line crosses Ranch border and a new 69/25kV sub in Sonoita; construct 15 miles of 69kV on southern border.
T4: TEP 46kV Transmission Supply	Tap TEP 46kV lines and construct new 46/25kV substation along Routes 82 east of Sonoita
T5: Underground Transmission Cable	Consider constructing underground transmission cable for T1 through T3 alternatives
Demand-Side Management	
DS1: Targeted DSM	Aggressively pursue energy efficiency and load management alternatives for residential, commercial and industrial customers served by the V-7 feeder
DS2: Electric Storage Heating	Aggressively pursue conversion of existing electric space heating for residential and commercial customers served by the V-7 feeder
DS3: Incentive Rate Option	Adopt time-of-use pricing to incentivize customers to reduce or shift peak demand usage to off-peak hours
DS4: Space Heating/Fuel Switching	Develop program to convert existing electric space heating systems for residential and commercial customer to alternate fuels
DS5: Combination of above	Combinations of Alternatives DS1 through DS4
Renewables & DG	
R1: Solar Photovoltaic	Promote programs to install PV on rooftops and ground-based systems for customers served by V-7; includes large utility-owned PV
R2: Concentrated Solar Power (CSP)	Develop single or distributed CSP systems on suitable sites near the V-7 primary lines; includes ground-based and distributed CSP
R3: Wind Generation	Develop utility-owned or third-party wind farm on suitable sites near the V-7 primary lines
R4: Energy Storage	Develop utility-owned or third-party energy storage systems; most likely at Sonoita substation site
R5: Distributed Generation	Install utility-owned diesel or natural gas DG; most likely at Sonoita substation site

Assessment of Supply Alternatives

Evaluation Methodology

In the following section, a screening analysis identifies options among the above alternatives deemed to be *technically* feasible. Options that meet screening criteria were then analyzed in greater detail from a technical, economic and environmental perspective.

Alternatives considered for meeting long-term electrical demand include demand and supply-side options. Supply-side options include expanding or adding new line or substation capacity, whereas demand-side options include conservation and DSM. We also investigated the implications and viability of a status quo option, which assumes no additional station or feeder capacity; but relies, instead, on other mitigation measures to resolve reliability issues and free up capacity to meet future demand.

NCI performed life-cycle economic analyses of the alternatives using economic and financial data commonly used by electric cooperatives. Alternative supply options considered include upgraded distribution lines, new transmission line and substations, renewable energy, fossil-fuel generation, and targeted DSM. Each alternative and resulting business case was assessed using an evaluation framework comparable with other capital projects. This approach ensures project ranking and evaluation factors were applied consistently among alternatives. In particular, the ability of each option to meet minimum criteria with regard to level of **"firm, reliable"** capacity over time was a key factor in the evaluation of alternatives; DSM and renewable options should provide the same degree of firm capability as T&D supply so as not to favor one concept over others.

Screening Criterion

A screening analysis was performed to limit more detailed evaluation and feasibility analyses to options that are viable from a technical and economic perspective. The following criterion was applied to identify options that are deemed to be potentially viable solutions.

» All solutions should be able to meet capacity and performance requirements over a 20-year study horizon. Key performance requirements include primary voltages no greater than 126 volts and no less than 114 volts. Solutions also should not exceed continuous normal or allowable equipment overloads. The lower voltage threshold assumes transformer taps can be set maintain service level voltages to 114 volts.

- Any individual component or program where several measures are considered should be able to meet capacity needs for at least five years; for example, DSM options should be able to defer capacity upgrades for at least three to five years (to provide sufficient time to implement other solutions – i.e., a hybrid option - before capacity shortages occur).
- All solutions that include installation of physical assets should have a minimum life of 20 years; this criterion does not apply to options where normal replacement of parts or other equipment is less than 20 years.
- All solutions must utilize technology that is commonly available and deemed to be mature; that is, the technology has advanced beyond the pilot or demonstration phase.
- All DG and renewable energy solutions should be able to meet capacity and performance requirements without exceeding feeder loads as measured at the Huachuca substation. Generally, this means the total rated *output* of these options should not exceed load at any hour of the days. It excludes options where output production can be adjusted via local or remote controls.
- All solutions should have the same level of effective firm capacity as conventional feeder expansion or upgrade options. Generally, the net availability should exceed 99.9 percent.
- Fossil fuel options cannot exceed or violate state of federal emission standards, where applicable.
- All solutions must have a reasonable likelihood of receiving regulatory approval, with sufficient economic justification to support the option.
- Options that have essentially the same or lower performance and environmental impacts than other similar alternatives, but at considerably higher cost will be excluded.

Alternatives that did not meet one or more of the above criterion are listed below, along with the reasons or rationale applied to eliminate the option from further considerations.

(1) Distribution

- Reinforce Existing System (D1) – The existing system has performance problems and capacity needs that cannot be solved by relatively minor upgrades and adjustments to the existing system. The capacity limits of the existing V-7 feeder will not materially increase with minor load balancing. Further, substation transformer capacity is near or at nameplate ratings and will need to be upgraded.
- Reconductor V-7 Line (D2) – The minor reduction in line impedance achieved by reconductoring (mostly reduced line resistance as opposed to reactance), does not

materially improve voltage performance, nor does it provide an measurable increase in capacity. Also, substation transformer capacity is near or at nameplate ratings and will need to be upgraded. The cost and time needed to obtain easement rights also presents major challenges.

» Static Var Compensation (D5) – The performance problems on the V-7 feeder are not likely to be corrected by SVC, which can stabilize voltages and sags caused by large motor starts or reactive power deficits, neither of which are predominant issues on V-7. Also, SVC provides no measurable capacity support.

(2) Transmission

» 138/115kV Transmission Supply Option (T3) – While technically feasible, the cost of higher voltage transmission tap is not justified given the amount of load served, and the need to use rights-of-way proposed for 69kV options or acquire new rights-of-way.

» TEP 46kV Supply (T4) – Preliminary power flow studies indicate that the line could not serve V-7 load while supplying the entire Fort Huachuca load due to low voltages along the line (some of which were as low as 0.80 per unit). The cost of up to 54 miles of 46kV upgrade likely would be twice the cost of other feasible options.

» Underground Transmission (T5) – While technically feasible, undergrounding the proposed 69-kV transmission line would likely cost $40 to $50 million (or greater), well above those of other options. Similar construction in rural areas generally is undertaken by utilities, as regulatory agencies generally will not approve much higher cost options absent strong justification and potential for setting precedents that other customers would likely ask for as well. Such justification does not appear to exist for this project.

(3) Demand Side Management and Incentive Rates

» Targeted DSM (DS1) – While aggressive DSM may be cost-effective and provide benefits independent of area capacity needs, even large increases above current programs levels is insufficient to materially defer the date for additional feeder and station capacity. Because the additional amount of DSM that could be achieved is uncertain, at best, it is not advisable to defer new capacity for the one of few years the need date could be extended.

» Incentive Rates (DS3) – Incentive rates, regardless of the rate differential, is very unlikely to have a measurable impact on peak usage. Industry studies indicate on versus off-peak ratio of two and three to one have a very minor impact on customer electric usage. SSVEC's current TOU rates, which have a two to one price differential has limited interest and participation for customers served by the V-7 feeder.

However, incentive rates would be used for electric storage heating options that passed the screening process.

(4) Renewable Generation and Distributed Generation

- Photovoltaic (R1) – Both rooftop-mounted and ground-based PV is insufficient to defer capacity due to the limited amount of firm capacity coincident with the early morning peaks. At minimum, five to six **MW's** would be needed to provide sufficient offsets under favorable conditions. However, the intermittent nature of PV does not match other supply options from a firm capacity standpoint. Further, the amount of PV operating at full output may exceed actual feeder loads, thereby violating screening criterion.
- Concentrated Solar Power (R2) – The absence of suitable flat sites for parabolic trough CSP and the high cost of these devices (coupled with high cost of remote and multiple interconnections) exclude CSP from further consideration. Further, most CSP is large – greater than 10MW – and would not be suitable for a distribution feeder. Other promising CSP technology that less slope dependent may be viable once they have achieved commercial status; however, all other technologies are still at the pilot or demonstration phase.
- Wind (R3) – Wind profile data for southeastern Arizona suggests wind generation opportunities are very limited, with insufficient firm capacity (near zero) to meet capacity deficits. Among other concerns, the highly intermittent nature of wind does not match other supply options from a firm capacity standpoint. Further, the amount of PV operating at full output may exceed actual feeder loads, thereby violating screening criterion.
- Energy Storage (R4) – The limited number of installations beyond the demonstration or pilot phase, and the few suppliers of sodium sulfur energy storage systems preclude this option as a commercially available, mature technology.

The screening analysis identified the following alternatives as potentially viable solutions. Each is analyzed in detail in the technical, economic and environmental assessment sections that follow.

- New 69kV supply (Sonoita & Buchanan substations, and double circuit) – T1 & T2.
- Fuel switching (Electric storage or fuel conversion) – DS2 & DS4.
- Fossil-fuel distributed generation – R5.

Although the foreign attachment alternative (UniSource 13.8kV/25kV tie) would be viable if studies indicated there was sufficient capacity and voltages were within limits; however, TEP notified SSVEC in a letter dated December 22, 2009 that it could not serve SSVEC load from the 13.8kV feeder originating in Nogales.

Technical Evaluation of Feasible Alternatives

The following summarizes alternatives from a technical perspective, including an assessment of how each option impacts the area's reliability. In addition, the ability of each option to address reliability criterion is assessed. Each option is evaluated based on the assumption that each must achieve minimum design and planning criteria to be viable.

Table 8: New 69kV Supply Options

Sonoita: New 69kV Supply & Substation (Sonoita) Voltage Drop and Losses at Peak (5656 MW)							
		Highest Voltage Drop					
Case	System Load(kW)	Phase A (V)	Phase B (V)	Phase C (V)	Net Losses (kW)	Losses (% of Total Load)	Total Load + Losses
Existing	5656	113	115	119	1648	29.1	7304
New 69kVa	5656	117	115	119	562	9.9	6218
New 69kV	5656	117	115	119	565	10.0	6221

Attachment 2 presents one-page summaries of each of the alternatives that were selected from the screening analysis. The summaries provide a brief description of the proposed solution, total cost, implementation timeframe, years the solution is viable, and advantages and disadvantages of each option.

Distribution Options

Most of the distribution options do not materially improve feeder performance or reduce feeder loading sufficiently to defer the need dates for capacity upgrades. For example, installing a dedicated 25kV feeder to Sonoita is expensive, visually similar to 69kV transmission and requires new ROWs where prescriptive rights prohibit upgrades in line capacity. Each also would require a new transformer with a higher capacity rating at the Huachuca substation.

Distributed Generation (Diesel or Natural Gas)

The injection of DG output on the V-7 feeder essentially reduces the effective loading on the circuit. The decrease in feeder loads also reduces substation transformer loading, improves feeder voltages and reduces losses. Table 9 presents the impacts of DG on V-7 feeder performance in increments of 500kW up to a total of 2000kW. The impact of increasing amounts of DG located in Sonoita on line end voltages is nominal. However, the reduction on losses at peak is substantial: losses as a percent of feeder peak demand drops from 30 percent to 17 percent if 2000kW is installed. Viewed from a capability standpoint, the net effective capacity of 2000kW of DG is actually 2746kW, an increase in net unit rating by about 35 percent.

Table 9: DG Feeder Impacts

Sonoita: DG Voltage drop and Losses at Peak (5656 MW) + DG							
	System Losses	Highest Voltage Drop				Losses	Load +
DG (KW)	Regained	Phase A (V)	Phase B (V)	Phase C (V)	Net Losses (kW)	(% of Total Load)	Losses – DG (kW)
0	---	113	115	119	1683	29.8	7339
500	227	114	115	119	1456	25.7	6612
1000	437	116	115	119	1246	22	5902
1500	602	116	115	120	1081	19.1	5237
2000	746	117	115	119	937	16.6	4593

Long-Term Performance of Feasible Supply Options

All 69kV transmission and substation options provide robust capacity support over 20 years (and longer), and improve power quality and feeder performance. For DG options, up to 2 MW will be sufficient to maintain voltages within acceptable levels; however, an additional 2 **MW's** is needed over the longer term. Figure 33 presents transmission and distributed generation performance for 2029. Results indicate all options meet voltage performance thresholds (under the assumption that 4 MW of DG or load reduction is achieved in 2029). The transmission option has lower losses, but comparable voltage performance.

Figure 33: Alternative Performance (2029)

2029 Peak Forecasted Loads Voltage Drop and Loss Comparison 2MW & 4MW DG and 69-kV Option							
		Highest Voltage Drop			Losses		
2029 Forecasted Load (Low, Base, High) kW	DG (KW)	Phase A (V)	Phase B (V)	Phase C (V)	Net Losses (kW)	(% of Total Load)	Load + Losses – DG (kW)
DG & Energy Storage							
7197	2000	112	113	118	1543	21	6740
	4000	115	113	118	927	13	4124
7922	2000	107	112	117	1907	24	7829
	4000	115	112	118	1142	14	5064
8723	2000	103	110	117	2165	25	8888
	4000	113	111	118	1456	17	6179
69-kV Option							
7197	---	116	113	118	691	10	7888
7922	---	115	112	117	732	9	8654
8723	---	114	111	117	780	9	9503

Results presented above also indicate Phase A and B voltages are below acceptable levels in year 2029, and these would need to be resolved for whichever solution is selected.

Reliability Considerations

As noted previously, most outages impact less than 10 customers. Hence, none of the supply options cited above are likely to significantly improve V-7 feeder reliability – the 69kV supply options provide the greatest reliability benefit, as the separation of one feeder into four would reduce customer interruptions and average outage hours by up to 30 percent. Accordingly, reliability should not be viewed as a primary factor in the evaluation of alternatives. The exception would be a status quo option that does address projected capacity deficits. Any material increase in feeder loading without reinforcement or demand reduction likely would cause major outages from feeder protective relaying phase trips caused by overloads or line burn-down.

As noted in the Operations and Maintenance section that follows, the impact of recloser operations on DG and energy storage must be addressed if these strategies are pursued. The loss of generation under peak load conditions could cause lengthy outages to many or all customers on the V-7 feeder. Remote SCADA would be needed to limit the impact of temporary interruptions caused by recloser operations. Given the potential of these types of outages, the DG options could be deemed less reliable than transmission supply options.

Operations and Maintenance

As noted throughout this report, additional station capacity is needed to cover the long term. For the 69kV option, SSVEC operating and maintenance staff are very familiar with single-pole construction with off-road access; hence, we do not anticipate any inordinate demand on resources or technical support capability. Similarly, the new Sonoita substation is comparable to other SSVEC substations, and would not create any undue maintenance or staffing impacts.

For DG (diesel), SSVEC personnel would need supplemental training, as they are not trained to operate and maintain generation equipment, or fuel handling facilities. Additional staff may be required and these costs are reflected in the economic analysis. A high level of maintenance on these options would be essential, as SSVEC's customers would rely on the availability of this generation to meet capacity requirements: In short, the units must be available when called upon to avoid capacity shortages and attendant lengthy outages.

The DG option also would require monitoring and control systems to enable control center personnel to operate these units when needed. Sophisticated control strategies and equipment also may be needed to automatically start (and shut off) the units when loads exceed pre-set thresholds or when contingencies or outages occur. It is important to note that a key shortcoming of all generation options is that these devices are designed to shut down for momentary or sustained circuit interruptions. If the Huachuca substation recloser were to operate (and successfully reclose) during peak load hours, there could be insufficient capacity with resultant overloads until the units were restarted. Control center personnel would need to intentional isolate or trip line sections until the generators were back on line. Accordingly, remote SCADA operating capability of line switches would need to be installed; the cost of additional SCADA control is added to the cost of these options.

Fuel Conversion and Storage

Reduction of electric space heating load via fuel conversions or by converting existing baseboard systems to electric storage can be an effective option if SSVEC can achieve sufficient participation levels and implement processes to minimize the potential for customer bypass or override of these systems. On-going performance evaluation and assessment would be essential, and program adjustments would need to be made, where needed. The cost of ongoing program administration, marketing and evaluation is included in the economic evaluation. A survey of customers served by V-7 is recommended to determine the number and type of space heating load, program design, and level and type of incentives needed to ensure sufficient participation.

To meet capacity requirements, a feeder peak target of 5000 kW, net of losses, was chosen to determine the minimum number of units for conversion. Significantly, the number of units in 2010 exceeds 100; hence, an aggressive program would be needed to achieve this target. Table 10 identifies the number of units that would need to be replaced by year.

Table 10: Space Heating and Electric Storage Conversions

Year	Capacity Reduction (kW)	Units Replaced (Cumulative)
2010	602	135
2019	1593	357
2029	2922	655

In later years, a large number of units would need to be converted to meet capacity reduction targets. In the last year, about 25 percent of the total customers served (prior to new customers added to the system) would need to own eligible space heating units and agree to participate in the program.

Economic Evaluation

A 20-year economic analysis was performed for the feasible alternatives outlined above. The economic analysis considers capital, energy, operations and maintenance, loss impacts and other specific costs needed for the option to remain viable over time. Capital costs of the feasible alternatives are summarized below in Table 11. The cost of the transmission options generally conform to prior estimates prepared by SSVEC, whereas the cost of the DG and conversion options, including incentive payments, were derived by NCI. All data used to derive energy and demand cost savings was based on SSVEC rate schedules, actual costs for demand and energy, and 2010 budget projection for demand and energy supply, and energy delivery charges. The specific cost of each alternative varies over time as facilities are added or incentives paid for DSM options.

Table 11: Capital Costs

Alternative Investment Cost	Cost	Units
69kV to Sonoita: SIDB Route	$15000	($000)
69kV to Sonoita: SR 82	19000	($000)
DG – Diesel	$600	$/kW
DG – Permitting	$250	($000)
Electric Heating Program Set Up	$250	($000)
Storage/Propane Unit	$1800	($)

Base Case Studies

Table 12 summarizes the results of the economic comparison studies of those options deemed to be most feasible. Results indicate reduction in peak electric heating use produces the lowest costs when evaluated over 20 years. Reduction in electric heating use assumes SSVEC customers would agree to permanently convert existing electric heating systems to alternate systems such as modular propane units or electric storage heating. Installation of diesel generation also represents a lower cost option.

Table 12: Economic Comparison of Feasible Alternatives

Alternative	Capital Investment	Fuel and O&M	Line Loss Savings	Total NPV
New 69kV to Sonoita (T1)	$13,424	$231	$879	$ 12,776
New 69kV to Sonoita (T2)	$17,004	$288	$879	$16,413
DG – Diesel (R5)	$2,277	$3,892	$418	$5,751
Electric Heating Conversion (DS4)	$1,386	$1,428	$460	$2,355
Electric Storage Heating (DS2)	$1,788	$ 350	$77	$2,061

Notes:
(1) All results in thousands of dollars (net present value)

Although economic results appear favorable, the viability of electric heating options is at best uncertain, as the level of incentive and marketing efforts that would be sufficient to motivate customers is unknown. The willingness of customers to remove existing heating systems and replace them with alternate systems has not been established. Further, there is uncertainty as to whether there are a sufficient number of eligible heating systems to reliably meet feeder demand and mitigate performance issues. For example, customers that use heat pump would not be eligible for either fuel switching or storage heating. Further, both DG and fuel switching options do not materially reduce momentary interruptions and voltages sags, nor do they address power quality issues; including those created by high load imbalances and possible circuit resonance.

Sensitivity Analysis

The primary sensitivity analysis focuses on load growth, as it has the greatest impact on DG and DSM options. In particular, the number of units and operating hours would increase significantly if growth were higher; conversely, the number of units and operating hour would decline if loads are lower. These findings suggest DG has greater flexibility and uncertainty than transmission/substation options, the latter of which is robust under all growth scenarios. The impact of load growth on fuel switching and conversion could have similar impacts, as a high growth scenario might exhaust the availability of eligible (or participating) customers.

Preferred Alternative(s)

The preferred alternative on the basis of economics alone is demand reduction, achieved by the expedited conversion of electric space heating with alternate fuels. A close alternative is the installation of diesel generators in Sonoita. Each of these options involves important trade-offs. The fuel switching option is speculative at this time, and SSVEC would need to implement, market and deliver a program that would achieve demand reduction in amounts sufficient to improve feeder performance and defer capacity upgrades for several years. The diesel option closely follows electric heating conversion options, and is more predictable with regard to certainty of capacity and performance benefits.

The preferred alternative based on feeder performance and firm capacity requirements is the construction of new 69kV line along the Ranch where SSVEC has easement rights.

Timing and Implementation

The six-month public review of alternatives outlined herein suggests the installation of longer term options could create short-term capacity constraints. Action needs to be taken *immediately* by SSVEC to avoid equipment overloads. Accordingly, the impact of new service applications onV-7 and Huachuca substation loading should be carefully evaluated.

The availability of diesel generation should not be a factor, as many devices are available for immediate purchase. However, if an air quality permit is needed for diesel generation, then sufficient lead time is needed to ensure devices are available for the next peak season.

The timing of fuel switching or storage heating could be an important factor, as a relatively high participation level likely is needed to achieve sufficient peak capacity reductions. 100 or more participants likely would be needed by 2010 for the program meet capacity needs.

Regulatory and Legal Considerations

The primary regulatory and permitting issues are likely to apply for the DG option. The size of the diesel indicates an air quality permit would be needed. The permitting process requires estimates of emissions for each unit (presented in the next section of this report). The length of time needed to obtain approval based on the size and operating is not known; however, any significant delays would cause V-7 performance to degrade with potential equipment overload. In addition, local permits likely would be required, and SSVEC would likely have to demonstrate that acceptable noise abatement systems would be installed. Area residents and businesses also could pursue separate legal action which also could delay construction.

For the electric storage heating option, SSVEC may need ACC approval for new time of use rates and program incentives. They would also need to confirm that program approval is not required by the ACC.

For the transmission construction option, the most significant factor is the need to obtain easements for the T2 option. Easements would need to be obtained along virtually the entire length of SR 82 and the Lower Elgin Road, a potentially lengthy (and costly) process. If condemnation is required, the additional time required for legal proceedings and fair value determination could delay construction for up to a year (or longer). Similar to DG permitting issues, any significant delays would cause V-7 performance to degrade with potential equipment overload.

Environmental Factors and Site Selection

This section highlights our investigation of environmental impacts associated with the development of the proposed alternatives, including the Sonoita 69kV line routing and substation options. To facilitate reference, the transmission line route option being proposed by SSVEC, which runs from a new substation site in the Sonoita area, across the Ranch to an interconnection east of State Highway 90 and north of Huachuca City is referred to herein as T1: New 69kV line & Sonoita Substation on Ranch ROW. Four viable subroute options (T1-A through T1-D) are also discussed in this section. Attachment 1 shows the general project area, including the transmission supply alternatives T1-A through T1-D, in addition to other alternatives evaluated in prior sections of the report.

The Visual Resources and Aesthetic analysis focuses on an evaluation of the Transmission Supply Alternatives. The Cultural and Historical Resources and Biological Resources evaluations focused primarily on Transmission Supply Alternatives –T1 and proposed new substation at the Sonoita Substation site. Potential construction related air emissions from the Transmission Supply Alternatives as well as potential air permitting issues associated with Supply Alternative R5: Distributed Generation is also discussed. This section also includes a discussion of the potential EMF impacts associated with the applicable supply alternatives.

The analysis of environmental impacts was completed at the feasibility level only and does not provide results or data in sufficient detail to complete any necessary environmental or permitting processes. This section includes an identification of potential feasible mitigation measures that would generally be sufficient to reduce substantial impacts associated with supply alternative being considered. This section does not evaluate individual project specific impacts for a particular alternative against specific environmental significance criteria and propose specific mitigation measures for each measured impact. Site-specific analysis of potential environmental impacts associated with the alternative ultimately selected would likely be required in order to determine the most appropriate mitigation strategies.

Visual Impacts and Aesthetics

NCI retained Environmental Vision, a visual resources impact and assessment firm, to assess the relative visual impact and evaluate visual resource constraints associated with alternatives being considered to improve the electric supply and performance of SSVEC's Huachuca V-7 feeder (see Exhibit 2). This section outlines the general physical characteristics and constraints associated with applicable alternatives. Visual mitigation strategies designed to generally address potential visual impacts are also provided.

This evaluation was based on review of available technical data including project maps, topographic and aerial maps, public planning documents, and geographic information system (GIS) data. In addition, a site reconnaissance of the general area of the Transmission Supply Alternatives was conducted on November 19, 2009, to observe general existing visual conditions. This section outlines the technical approach and methods employed for the evaluation and an overview of the visual setting in the project area. It includes a discussion of the physical characteristics, visual resources constraints and potential aesthetic impacts issues associated with each of the supply alternatives. A discussion of applicable aesthetic mitigation strategies and findings and conclusions is also included.

Of all delivery options, the Transmission Supply Alternatives have the greatest impact from a visual standpoint, in large part because several traverse ROWs where few or no other lines exist. However, one option, T4: 46 kV Supply Options, which involves an interconnect to TEP's 46kV line has virtually no impact from a transmission routing standpoint , as a new 46/24.9kV substation would be needed adjacent to Elgin Road but no additional sub-transmission line would need to be constructed.

Technical Approach and Methods

Visual or aesthetic resources are generally defined as the natural and cultural features of the landscape that can be seen. The combination of landform, water, and vegetation patterns represents the natural landscape that defines an area's visual character, whereas cultural features include built elements such as buildings, roads, and other structures that reflect human modifications to the landscape. These natural and built landscape features—or visual resources—contribute to the public's experience and appreciation of the environment. Depending on the extent to which a project's presence would alter the perceived visual character and quality of the environment, visual or aesthetic impacts may occur. As described below, several key factors provide the framework for evaluating relative visual constraints associated with the Supply Alternatives being considered.

The general area from which an object or project is visible or can be seen is defined as the viewshed. The existing physical and visual characteristics of the project's landscape setting provide a basis for evaluating project-related change within the viewshed. Viewing distance is a key factor that influences the level of project visibility. For visual resources assessment purposes, the viewshed area can be broken down into distance zones of foreground, middleground, and background. The foreground, defined as the zone within a half-mile from the viewer, is the area from which landscape detail is most noticeable and objects generally appear most prominent. This evaluation is focused on foreground areas, where visual change is typically most noticeable. The middleground is a zone that extends from the foreground up to three to five miles from the viewer, and the background extends from about three to five miles to infinity (Smardon et al., 1986 and U.S. Department of Agriculture, 1973). In instances where viewing distances are referenced as part of this evaluation, all measurements are approximate.

Viewer sensitivity as well as the relative number of affected viewers are additional factors that influence the magnitude of potential aesthetic impact. Research on the subject suggests that certain activities tend to heighten viewer awareness of visual and scenic resources, while others tend to be distracting (U.S. Department of Transportation, Federal Highway Administration 1988, p. 63). Accordingly, each of the applicable Supply Alternatives being considered was evaluated in terms of its proximity to key visual receptors including (1) state and county scenic routes, (2) existing residential areas and (3) open space and public lands. For purposes of this study, location of sensitive visual receptors within 0.25 mile was employed as the constraint criterion because physical elements such as transmission structures have potential to be noticeable or to appear prominently when seen in the foreground at this distance. An additional factor, the presence of existing distribution or transmission facilities, was also considered pertinent to the evaluation because the presence of these facilities generally decreases the level of incremental change which in turn changes the degree of visual impact as compared with the introduction of similar facilities in landscape settings where existing similar features are not currently present.

One exception to the 0.25-mile distance criterion was applied with respect to the proximity of the Supply Alternatives to visual receptors. A more detailed visual assessment is included for the four applicable transmission supply alternatives, which include route variations in the area surrounding Sonoita Hills and the proposed Sonoita substation (i.e., T1-A through T1-D). In these areas, a proximity of 200 to 300 feet was employed as the evaluation criteria.

Visual Setting Overview

Landscape Context

Located approximately 50 miles southeast of Tucson, Arizona, the general project area straddles Santa Cruz and Cochise Counties. This area is part of a larger physiographic region known as the Mexican Highland, which includes high desert plains situated at between 4,000 and 7,000 feet above sea level and mountains rising to higher elevations (Fenneman, 1931). The general project area lies at an elevation between about 4,200 feet and 4,900 feet above sea level. Mountain ranges surrounding the project area include peaks of up to 9,000 feet. Views from several locations in the general project area include desert grassland plains with distant mountain ranges as a backdrop (Attachment 3 - Photo 1).

The general project area lies within the Mexican Highland Scrub Steppe Province ecoregion (Bailey, 1978), a high desert landscape characterized by light-colored rolling grassy plains with darker grey-green, scattered scrubby shrub and tree cover (Attachment 3 - Photo 2). It is an arid climate with precipitation limited to summer storms and occasional winter rains. The grasslands generally experience a brief seasonal change to green with rainfall. Groups of mature trees are limited to areas along streambeds and washes, and near developed areas including residences (Attachment 3 - Photo 3). Landscape texture ranges from medium-fine grain in grassland areas to a coarse grain in scrub areas. These characteristics suggest that the **landscape's "visual absorption"** capability, or the ability of the landscape to accept human alteration without a loss of scenic quality character, ranges from low in more level grassland areas where built objects may contrast with the smoother texture to high in scrub areas where the mottled, hilly landscape background has the potential to camouflage built structures. Views within this landscape are typically open and unobstructed; but occasionally enclosed or interrupted by topography, trees and other vegetation or buildings (Attachment 3 - Photo 4).

A roadway network including SR 82, SR 83, and SR 90 connects the area to larger urban centers--Tucson to the north, Nogales to the south on the Mexican border, and Tombstone/Sierra Vista to the east. The project area is sparsely settled with low-density residential structures near the unincorporated towns of Sonoita (Attachment 3 - Photo 4 and 5, Huachuca City; Attachment 3 - Photo 6) and Whetstone - ranching is the predominant land use. Nearby public land includes Bureau of Land Management (BLM) areas, the Coronado National Forest, and the Fort Huachuca military base equipped with ongoing military training facilities and an airstrip. Rural residences, ranch structures including fences, and existing utility lines are among the established built features seen in this landscape setting.

Visual Resources and Potential Receptors

Visual resources and potentially sensitive visual receptors in the general project area include the following:

» Patagonia-Sonoita Scenic Road: A 52 mile scenic road following SR 82 and SR 83 from Nogales to Sonoita to Tucson, running along the riparian basin of the Santa Cruz River (Santa Cruz County, 2004).

» Rural residences: These include residences around the unincorporated communities of Sonoita (Attachment 3 - Photos 3 and 5), Elgin, Whetstone, Huachuca City and locations along the southern edge of the Ranch, near Highway 83.

» Las Cienegas National Conservation Area (LCNCA): A 45,000 acre BLM administered area that stretches across Santa Cruz and Pima Counties. The BLM has numerous policies regarding aesthetics which apply to this area.

» Babacomari Ranch: An approximately 55-square mile privately-owned historic property that straddles Santa Cruz and Cochise Counties. The ranch is largely undeveloped with some rural residences at the eastern and western periphery

(Attachment 3- Photos 2 and 7). Various fencelines and several existing utility lines traverse the ranch property (Attachment 3 - Photo 8).

» Appleton-Whittell Research Ranch: An approximately 4.5-square-mile undeveloped tract of land located south of the Ranch that is managed as cooperatively by groups including the National Audubon Society, U.S. Forest Service, BLM, and the Nature Conservancy. Public access to this area is restricted (Audubon, 2009).

» Fort Huachuca Military Preserve: An approximately 70,000 acre tract of land that is located adjacent and to the south of the Ranch.

Potential Visual Impact Issues and Physical Characteristics of Supply Alternatives

This section evaluates supply alternatives that have potential visual resources issues. All of the supply alternatives being considered were previously identified in Exhibit 2. Attachment 1 is a map of the general project area showing its landscape topography pattern and the location of the transmission supply alternatives. Specific sites for renewable options have not been chosen as the feasibility study did not identify preferred sites. It is assumed that DG options could be located on the Sonoita substation site. Because DSM options do not involve physical improvements to facilities they would not result in any visual effects and, therefore, are not addressed in this evaluation.

Distribution Alternatives

The distribution alternatives require some modifications at existing substations and minor modifications or additions to existing distribution lines. Distribution lines generally utilize wood poles less than 40-feet tall. Because of this, it is expected that the changes proposed by the distribution alternatives would generally be minor and incremental, the visual effects would generally not be particularly noticeable and would range from no change to a minor level of visual change.

D1: Reinforce Existing System

This option utilizes rebuilding of existing distribution lines and does not require new utility structures, therefore there will not be any visual effect associated with this option.

D2: Upgrade Existing Line

This option involves rebuilding of existing distribution lines and replacing a limited number of existing poles with taller poles and replacing existing conductors. Given the minor level of modification to existing elements, the visual effect would not be particularly noticeable.

D3: New Huachuca West Feeder
This option involves some modification to the existing Huachuca West substation as well as replacement of approximately 25 miles of existing distribution line with a double-circuit distribution line on taller poles along SR 82 and Elgin Road. The replacement poles would be 10 to 15 feet taller. Because this option involves a 25-mile route along public roadway corridors, and given that the new poles would be taller and would carry additional conductors, the visual effect would be noticeable.

D4: Foreign Interconnection
This option involves building approximately two miles of new distribution line along SR 82 (registered Arizona Scenic Highway) at the southwest corner of the project area. This option will result in a minor level of visual effect.

Transmission Supply Options

This section evaluates the Transmission Supply Alternatives being considered and identified on Attachment 1 as T1(A-D), T2, T3 and T4. The 69 kV alternative routes (T1A – T1D) and (T2) and 115/138 KV route (T3) each involve establishing a new substation and up to 23 miles of new lines. The new sub-transmission lines would utilize steel poles from 55 to 65 feet tall. T4: 46kV Supply Options would involve establishing a new substation and utilizing existing transmission lines and no new lines would be required. Generally, the Transmission Supply Alternatives would introduce new sub-transmission facilities in areas that include remote rangeland, rural residential areas, and a mixed commercial area.

T1: New 69 kV Supply Options
This alternative involves installing approximately 23 miles of new 69 kV transmission line. This line would run between the proposed Sonoita Substation located approximately 0.5 mile south of the intersection of SR 82 and SR 83 (Attachment 3, Photo 9) and proceed easterly to the City of Huachuca at SR 90 (Attachment 3, Photo 6). This route option runs south and east through rural residential areas of Sonoita. In this area, four route variations (T1-A, T1-B, T1-C and T1-D on Attachment 1) are under consideration for the 69 kV routes within a small portion of this route that encompasses about the first 4.5 miles. Photos 3, 4, 5 and 9 in Attachment 3 provide views in this part of the general project area. The route then runs across and along the largely undeveloped Ranch (Attachment 3, Photos 2, 7 and 8). As outlined below, approximately 7.8 miles of the route is near residential areas, and the majority of it passes through largely unsettled, remote areas of rugged terrain. Approximately 19 miles would involve installing new transmission line in areas where there are no existing distribution or transmission lines.

- Approximately 7.8 miles of this route lies near rural residential areas in Sonoita, the City of Huachuca, and near SR 83 along the Ranch.

- This option passes through or along the edge of approximately 19.3 miles of the Ranch. Most of the route passes along the ranch's southern edge.
- Approximately 1.5 miles of the route is adjacent to the northern edge of the Appleton-Whittell Research Ranch.
- Approximately 4 miles of the route is adjacent to SR 83.
- Another 0.3 mile of the route runs along local roadways.
- Approximately 4-5 miles of the route is adjacent to existing distribution lines.

Variations in Sonoita Area

Table 13 includes an evaluation of visual constraints associated with four route sub-options (T1-A, T1-B, T1-C and T1-D in Attachment 1) located along approximately 4.5 miles at the western end of this Transmission Supply Alternative T1. In comparison to the other variations shown in the table below, the T1 –A route has the least visual constraints due to its relatively lower exposure to residential and roadway views. In addition, most of this route variation follows existing distribution lines which would tend to decrease the degree of noticeable visual change.

Table 13: Visual Constraints of T1 Route Options

Option	Close Proximity to Residences (miles off the SIDB)*	Presence of Utility Lines (miles off the SIDB)	Adjacent to SR 83 (miles off the SIDB)
T1-A	1.75	3.0	1.5
T1-B	2.5	2.5	1.75
T1-C	1.75	3.0	4.5
T1-D	3.0	2.5	0

T2: 69 kV Line Supply Options

This alternative involves installing approximately 23 miles of new 69 kV sub-transmission line running from the new Sonoita Substation to the existing Huachuca West Substation on SR 82 approximately 0.3 mile east of SR 90. The line runs north along Lower Elgin Road and then follows SR 82 through the Rain Valley to the north of the Mustang Mountains and into Whetstone. As outlined below, this route option passes near more residential areas than the T1 and the T1A through D options. However this entire route is adjacent to existing distribution lines where utility poles are established features in the landscape.

- Approximately 11.1 miles of the route passes within 0.25 miles of rural residential areas in Sonoita, Elgin, and Whetstone.

- Approximately 4 miles of the route runs through or along side the LCNCA.
- Approximately 11.7 miles is adjacent to SRs 82 and 83.
- Approximately 8 miles runs along local roadways.
- The entire route is adjacent to existing distribution lines.

T3: SWP 138 kV/115 kV Transmission Supply

This Transmission Supply Alternative would utilize a portion of the SWTC line that runs from SR 82 near Granite Peak Road southeast through a portion of the Mustang Mountains and across the Ranch. It would involve installing a new substation at the SWTC 138kV line just north of the Ranch property boundary and installing a new 69 kV sub-transmission line south across the Ranch. At the southern Ranch boundary the T3 Supply Alternative would follow the T1 route west to the proposed Sonoita Substation location. This option is similar to the 69 kV T1 or T2 options described previously but includes a shorter distance of new transmission line. A new substation along SR 82 could be visible from the roadway whereas, because of the remote area, a substation near the Ranch would generally be less visible from public viewing locations.

T4: New 46 Line Tap (TEP) and Substation

This Transmission Supply Alternative involves building a new substation only and does not require any new utility line. Utilizing a portion of the TEP right-of-way from Lower Elgin Road to the southern border of the Ranch, a new substation would be installed along Elgin Road near Wildlife Lane. Modifications to the existing 46 kV line would be minor and not would result in noticeable landscape effects. The proposed new substation would be a noticeable new element in the landscape. Aesthetic issues regarding the substation include the following:

- The substation lies within 0.25 mile of 2 rural residences on Elgin Road.
- It is within 0.25 mile of the LCNCA.

Demand-Side Management

These Supply Alternatives, identified as DS1 to DS5 in Exhibit 2, do not involve improvements to physical facilities and, therefore, they would not result in visual impacts.

Renewables and Distributed Generation Options

Four different Supply Alternatives are evaluated below. Although none involve site-specific locations, one of the alternatives (R5) could be developed at the proposed Sonoita Substation site or a comparable site in the general area.

R1: Solar Photovoltaic
The Solar Photovoltaic option could involve roof-top-mounted panels on scattered-sites or larger centralized facilities. Depending on the specific site locations and/or type of panel, this option could be visible and to varying degrees could become a source of glare. Therefore, this option has the potential to have a minor level of visual effects.

R2: Concentrated Solar Power
This option involves a centralized facility with an array of reflectors focused on a tall collector tower. Depending on the specific location of the site, reflective panels could be a source of glare and the tower could appear prominent from adjacent public roadways, residential areas, or public open space. This option has the potential to result in minor to substantial levels of visual effect.

R3: Wind Generation
This option was deemed not feasible in the early stages of the assessment of alternatives and therefore, excluded from this evaluation.

R4: Energy Storage
This option involves installing equipment enclosure structures at an existing or new substation site. This type of facility could be visible from nearby locations at the new Sonoita Substation site or comparable locations. However, the facility's appearance would be compatible with the visual character of a surrounding largely commercial and light industrial setting. With aesthetic mitigation including landscaping, the visual impact would be minor.

R5: Distributed Generation
This option involves installing low-profile equipment enclosure structures at an existing or new substation site, this type of facility could be visible from nearby locations at the new Sonoita Substation site or comparable locations. However, the facility's appearance would be compatible with the visual character of a surrounding largely commercial and light industrial setting. With aesthetic mitigation including landscaping, the visual impact would be minor.

Visual Mitigation Strategies

This section outlines a set of mitigation measures designed to reduce potential visual impacts and aesthetic effects associated with those Supply Alternatives that have potential visual resources issues, as discussed in the above section. Because aesthetic mitigation treatments will need to address particular landscape settings and viewing conditions, site-specific analysis of potential visual impacts could be required in order to determine the most appropriate visual mitigation strategies. For example, aesthetic mitigation could be required for a new substation situated within proximity to a public roadway, or a minimum setback could be appropriate for new poles located near existing residences. Site-specific conditions may also require focused analysis including visual simulation or landscape mitigation studies. Mitigation measures will also need to address the specific physical characteristics of the selected supply alternative. The mitigation measures identified below are independent of those which may have already been proposed by SSVEC. Therefore, mitigation measures provided herein may be the same as or similar to those already proposed or normally implemented as a part of SSVEC operations.

Construction (C)

» **C1:** Where new poles or substation facilities are installed or where other visible ground disturbance occurs, construction practices should include earth re-contouring and revegetation/landscape replacement to restore the appearance of disturbed areas.

Utility Lines (UL)

» **UL1:** Use of non-reflective finishes and appropriate pole color should be employed to minimize the project's visual contrast with the surrounding desert landscape.

» **UL2:** Non-specular and non-reflective conductors and insulators should be installed to reduce their potential visibility.

» **UL3:** Installation of narrow-profile mono-poles with smaller arms should be considered to reduce potential visibility of structures.

» **UL4:** In locations where residential views are affected, new poles should be carefully sited so as to reduce their visibility. This measure could include consulting with affected residents on pole placement.

» **UL5:** Where new transmission lines are installed adjacent to existing distribution lines, consideration should be given to underbuilding the transmission structures in order to reduce the total number of utility poles seen within the viewshed.

» **UL6:** In cases where new transmission lines are installed adjacent to distribution lines in particularly sensitive residential areas, undergrounding of distribution lines should be considered in order to reduce the overall height of poles.

» **UL7:** In cases where new structures are installed on or near public lands (i.e. BLM land, public open space), consultation should take place with jurisdiction staff regarding aesthetic design considerations including color and structure placement.

» **UL8:** Installation of landscape screening at select locations should be considered to reduce the visibility of new poles with respect to sensitive views from residential or public open-space/recreation areas.

» **UL9:** In locations where the visual effect of poles is greatest, consideration should be given to installing taller poles so as to achieve longer conductor spans.

Substations (S)

Note: The following mitigation measures may pertain to both substations and renewable and distributed generation options.

» **S1:** Non-reflective finishes should be used for equipment that is visible to the public in order to reduce potential glare effects, including non-specular components in substations.

» **S2:** Decorative perimeter walls or other architectural enclosure elements should be considered in order to screen facilities.

» **S3:** Installation of landscaping should be considered in order to screen facilities from residential and roadway views.

» **S4:** In cases where new facilities are installed on or near public lands (i.e. BLM land, public open space), consultation should take place with jurisdiction staff regarding aesthetic design considerations including color and structure placement.

Summary and Conclusions

As outlined in the evaluation above, varying types and levels of visual constraints are associated with the alternatives being considered. Overall, due to their proximity to public roadways, three options- T2, T3 and D3 could result in noticeable visual change that would be seen by the greatest number of viewers in the project area. Several options including D1 and the demand-side options would result in virtually no effect on existing visual resources or public views. A second group of options including D2, D4, R4 and R5 could involve a minor level of visual change. Depending on site locations, the solar renewable options R1 and R2 could result in a minor to substantial level of visual effect. Finally, the 69 kV Transmission Supply options (T1-A through T1-D) would represent the most substantial degree of visible change because each of these options would introduce more than 20 miles of new transmission line and a new substation facility into the landscape setting. In comparison to the T1-A through T1-D options, a greater portion of the T2 option would be visible from residential areas; however, because the T2 option lies along an existing utility line for almost its entire length, its potential visual effects would be less noticeable than the T1 route which involves the introduction of a new utility line along portions of alignments where none currently exists; however, the virtual absence of residential customers on major sections of the T1 route suggests fewer people would see the line on the southern section of the SDIB. With respect to the four possible variations at the western end of the T1 route option, T1-A would appear to be the least aesthetically constrained due to its relatively lower exposure to residential and roadway viewers.

Table 14 summarizes relative visual constraints associated with the various options under consideration. The table also includes corresponding applicable mitigation strategies. Importantly, as outlined above in the discussion of aesthetic mitigation measures could, to varying degrees, reduce the potential adverse effects associated with the identified visual constraints. Provided that appropriate site-specific aesthetic mitigation measures are incorporated into final design and implementation and based on the evaluation results summarized in Table 14, all of the options are considered feasible from a visual resources standpoint.

Table 14: Aesthetic Evaluation Summary

Options and Physical Characteristics	*Visual Constraints (Mitigation Strategies)*
Distribution	
D1: Reinforce Existing System Minor modifications to an existing distribution line.	No visual impacts. (N.A.)
D2: Upgrade Existing Line Replaces conductors and a limited number of existing poles with taller poles on an existing distribution line.	Minor changes to existing visual setting. (Mitigation: U1 through U4.)
D3: New Huachuca West Feeder Replaces 25 miles of existing distribution line with taller, double-circuit poles and conductors.	Minor but noticeable change to existing visual setting. (Mitigation: U1 through U4, and U7 and U8.)
D4: Foreign Interconnection Approximately 2 miles of new distribution line.	Minor changes to existing visual setting. (Mitigation: U1 through U4, and U8.)
Transmission	
T1: New 69 KV Supply Options along Ranch Corridor (T1A-D,) New substation and approximately 22 miles of new transmission line, line mostly through remote areas and some residential areas.	New line would mostly be in remote areas with limited visibility to the public. Noticeable visual change to some residential viewers and travelers along highways and local roads. Approximately 8 miles of the route are near residential areas and 19 miles of the 22-mile route will be in areas where there are no adjacent existing distribution or transmission lines. (Mitigation: UL1 through UL8 and S1 through S4.)
T2: New 69 kV Supply Option along Elgin Road and SR 82 New substation and approximately 23 miles of new line. Line is sited entirely along side existing distribution lines.	Noticeable visual change affects greatest number of residential viewers and travelers along highways. However, visual effect would be decreased somewhat because this route is located entirely along existing distribution lines, and could be combined with the existing lines. Approximately 11 miles of the route are near residential areas and 12 miles of the 23-mile route follow highways. May also require additional consideration regarding LCNCA (BLM).

Options and Physical Characteristics	*Visual Constraints (Mitigation Strategies)*
	(Mitigation: UL1 through UL8 and S1 through S4.)
T3: SWP 138 kV/115 kV Lines Could involve a new substation or a new 69kV line and/or reinforcement of an existing distribution line. Part of the 69 kV line would be located within the existing 115/138 kV corridor and part in areas with no existing transmission lines.	The existing transmission corridor and possible substation locations are in remote areas with few public viewing locations. The new substation and transmission line may be visible from roadways. The new 69kV line would generally be sited in areas where no distribution line currently exists. Changes would be noticeable. (Mitigation: UL1 through UL8 and S1 through S4.)
T4: New TEP 46/25 kV Substation New substation located along SR 82 in a residential area adjacent to LCNCA.	New substation could be noticeable to small number of residential viewers and travelers on a highway. Option may require additional consideration regarding LCNCA (BLM). (Mitigation: S1 through S4.)

Options and Physical Characteristics	*Visual Constraints (Mitigation Strategies)*
Demand Side	
No options involve changes in physical facilities.	No visual impacts. N.A.
Renewables and Distributed Generation	
R1: Solar Photovoltaic Dispersed-site rooftop locations or large-site, centralized solar cell facility.	Potential source of glare from panels. Because of lower profile, this option could be less noticeable than the other solar option. (Mitigation: S1 through S4).
R2: Solar Central Storage Large-site reflector array and tall tower.	Potential source of glare from mirrors. Central tower may be noticeable and prominent from public viewing locations. Depending on the specific site location, this option could be the more visible of the two solar options. (Mitigation: S1 through S4.)
R4: Energy Storage Equipment enclosures at existing or new substation facilities.	May involve new substation facility. Facility could be visible from public locations. With mitigations, visual impact could be minor. (Mitigation: S1 through S4.)
R5: Diesel Generation Low-profile equipment enclosures at existing or new substation facilities.	May involve new substation facility. Facility could be visible from public locations. With mitigations, visual impact could be minor. (Mitigation: S1 through S4.)

Cultural and Historical Resources

NCI retained Pacific Legacy, Inc., a cultural resources management firm, to complete a cultural resources evaluation of the general area of Transmission Supply Alternatives. To initiate the investigation, a record search was conducted at the Archaeological Records Collections Division of the Arizona State Museum (ASM), Tucson through the AZSITE data base system of Arizona's Cultural Resource Inventory. The record search was completed for an area including one-half mile on either side of the proposed T1 route. In addition, the record search included a one-half mile radius at both endpoints of the proposed T1 route (i.e., at the proposed Sonoita Substation location on the west and the interconnection to an existing SSVEC 69kV transmission line to the east). In addition, an Arizona Antiquities Act Blanket Permit and a Records Management and Repository Agreement was obtained through the ASM at the University of Arizona, Tucson which is required to conduct record searches and surveys within Arizona.

Record Search Results

Fifteen previously recorded archaeological resources and 11 previous cultural resource investigations were identified within one-half mile of the proposed T1 route. The results of the record search are summarized below. Maps depicting the project centerline, the record search limits and the nature and locations of the previously identified sites and investigations are not included in this report due to their confidential nature. Archaeological and other heritage resources can be damaged or destroyed through uncontrolled public disclosure of information regarding their locations. Information regarding the location, character or ownership of a historic resource is exempt from the Freedom of Information Act pursuant to 16 U.S.C. 470w-3 (National Historic Preservation Act) and 16 United States Code § 470hh (Archaeological Resources Protection Act).

Previously Recorded Sites

The 15 previously recorded sites consist of prehistoric resources (village sites with house pit depressions, architectural remains, cairns and artifact scatters) and historic resources (railroad grades, old road segments, adobe structure foundations, fort remnants and artifact scatters). Only three of the sites (AZ EE:4:43, AZ EE:6:63 and AZ EE:7:175) are located near the proposed T1 route. A brief summary of these three sites is provided below. A brief summary of the remaining 12 sites is included in Attachment 4.

AZ EE:4:43(ASM) - A railroad grade with features representing the New Mexico and Arizona Railroad which was constructed by the Atchison Topeka and Santa Fe Railroad and built between 1881-1882 and abandoned in 1966. The Arizona State Historic Preservation Office (SHPO) determined the site eligible for listing on the National Register of Historic Places (NRHP) under Criterion A (association with events that have made a significant contribution to the broad patterns of our history); however, some segments of the railroad have been determined to represent non-contributing elements (Purcell 2006-991.ASM; Railey and Yost 2003-910.ASM).

AZ EE:6:63(ASM) - A linear site consisting of in-use and abandoned segments of State Route 83 and associated features, most of which appear to represent intact 1920s rural highway segments. The site has been recommended as eligible for listing on the NRHP (Wright 1996-354.ASM).

AZ EE:7:175(ASM) - Segments of historic road representing parts of original State Route 90 which was built prior to 1940 and reconstructed in 1960s. The road segments have been recommended as potentially eligible for listing on the NRHP (Wright 1992-268.ASM). The segment of the site within the 2004 Rowe survey was reported as no longer existing and likely destroyed during installation of a telephone conduit and road maintenance activities (Rowe 2004-656.AMS).

Previous Investigations

There have been 11 previous archaeological studies within a half mile radius of the proposed T1 route. Only four of these studies (1996-354.ASM, 1999-337.ASM, 2004-656.ASM and 2006-991.ASM) overlaps with the proposed T1 route. A brief summary of these four studies is provided below. A brief summary of the remaining seven studies is included in Attachment 4. In addition to the studies identified by AZSITE, SSVEC retained Tierra Right of Way Services to complete a cultural resources survey of the proposed T1 route (Tierra, 2009).

1996-354.ASM
This linear survey of 40.4 miles of the State Route 83 right-of-way was conducted by Thomas Wright at the request of the ADOT prior to highway maintenance activities. Sixteen resources were identified including Site AZ EE 6:63 within the proposed project area which was recommended as eligible for the NRHP. The area covered by this study overlaps with the proposed T1 route.

1999-337.ASM
SWCA, Inc. conducted this archaeological survey for the Arizona Electric Power Cooperative, Inc. in advance of routine maintenance along an existing transmission line. Five newly identified and 22 previously recorded sites were identified, including Site AZ EE:7:263 within the proposed project area which was recommended as potentially eligible for the NRHP pending further study. The area covered by this study overlaps with the proposed T1 route.

2004-656.ASM
TRC Environmental Corporation conducted a linear survey of 24.5 miles along portions of State Routes 80, 90 and Interstate 10 prior to the installation of a fiber optic line. Five sites were identified, including AZ EE:7:175 within the proposed project area. However, the segment of AZ EE:7:175 within their project area was found to have been destroyed and no longer exists, apparently from installation of a telephone conduit and road maintenance activity. The area covered by this study overlaps with the proposed T1 route.

2006-991.ASM

A 406 acre survey for a proposed material source pit was conducted by David Purcell of DMG Four Corners Research, Inc. during which eight sites were identified including three within the proposed project area. The portion of Site AZ EE:4:43 within their survey was recommended as a non-contributing portion to the NRHP eligibility of the site. Site AZ EE:7:342 was recommended as eligible to the NRHP and Site AZ EE:7:343 was recommended as not eligible to the NRHP. The area covered by this study overlaps with the proposed T1 route.

Recommendations/Proposed Mitigation

The record search results from the ASM revealed three previously recorded sites within the area of the proposed T1 route. Twelve additional sites are located within a half mile of the proposed T1 route.

Accordingly, an archaeological survey of the proposed project area will be necessary should the project move forward. This archaeological survey should be completed for either the T1 route or any other alternative route that is ultimately selected for construction. If previously identified or newly identified resources are identified within the project area, they will need to be avoided if possible. Any holes necessary for pole installation should be placed to avoid digging within previously recorded or newly identified sites (resulting from the future archaeological survey). Any subsurface construction in the recorded or newly identified sites would be considered an impact to an archaeological site. This would require site evaluation prior to the impact, and if the site is determined eligible for the NRHP data recovery would also need to take place prior to construction.

Architectural resources have not been addressed in this report; however, it may be necessary to assess the visual impact of the project on NRHP sites and architectural resources of local interest. Changes to the visual setting of a NRHP eligible property is considered an impact. If there are existing visual impacts (e.g., existing power lines, highways and other visible constructions) a debatable premise is that the visual setting has already been compromised. The ASM policy for surveys of 640 acres or ten or more linear miles requires a research design or plan that is will review prior to fieldwork. In addition to a current blanket permit and records management/repository agreement (with appropriate maps of the project area), a Notice of Intent to conduct a survey on state lands (i.e., SR ROWs) must be submitted to the ASM. The ASM charges records management fees by per person field days and by the number of site records submitted to cover the cost of project processing and management. Additionally, if lands to be surveyed lie within areas with federal jurisdiction, SSVEC will need to submit and obtain approval for the appropriate special use permits prior to conducting surveys (i.e., BLM or Forest Service lands). The SHPO should also be contacted to inform them of the project.

Biological Impacts

NCI retained Harris Environmental Group, a biological resources management firm, to complete a biological resources evaluation of the general area of Transmission Supply Alternatives. A site visit of the general project area and proposed T1 route was conducted on November 19, 2009. The proposed transmission line route is located in portions of Santa Cruz and Cochise counties, Arizona.

The purpose of the site visit and biological resources evaluation were (1) to determine whether landscape characteristics, including wetlands, that occur with the proposed project area support special status species, and (2) to predict the likely effect of the proposed sub-transmission project on the species. A special-status species is defined as plants and animals that are legally protected under federal, state and/or local management agencies.

Information Reviewed

A list of federally-listed threatened or endangered species for Santa Cruz and Cochise counties was obtained from the U.S. Fish and Wildlife Service (USFWS) and was reviewed to determine if any of the species have the potential to occur within one mile of the proposed T1 route (USFWS, 2009). In addition, the Arizona Game and Fish Department's (AGFD) Online Environmental Review Tool was queried to determine whether any state listed threatened or endangered species or critical habitats have been documented within three miles of the proposed T1 route (AGFD, 2009). A literature search was also conducted for available biological resource studies or information for the general area. Copies of the USFWS and AGFD species lists are included as Attachment 5.

The potential for each special status species to occur in the general area was determined by comparing landscape characteristics in the area with the habitats known to be used by federally-listed species, AGFD listed-species, and all birds protected by the U.S. Migratory Bird Treaty Act. Based on the species list obtained from USFWS, no federally-listed species or their habitats have been identified to occur within the general area of the proposed T1 route. Habitat suitability requirements were based on qualitative comparisons between the habitat requirements of the species and biotic communities found in the general area.

Based on the results of the AGFD On-line Environmental Review Tool, eight out of 10 Arizona Wildlife of Special Concern that have been documented as occurring within three miles of the proposed T1 route do not have the potential to occur within the general area because habitat requirements necessary to support these species were lacking. For example, the general area does not have perennial water to support fish or amphibian species nor caves or mine adits to support bat species. The remaining two species , Baird's sparrow (*Ammodramus bairdii*) and

Sprague's pipit (*Antus spragueii*), both live in grassland habitat which does occur in the general area; these bird species have been documented as occurring within three miles of the proposed T1 route.

Existing Biological and Wetland Resources

Attachment 1 illustrates that a portion of the proposed T1 route follows the southern border of the Ranch property and crosses several ephemeral washes that flow north into the Babacomari River, including Turkey Creek. The Babacomari River is a large tributary of the San Pedro River, which is considered a Waters of the U.S. according to the U.S. Army Corp of Engineers. The San Pedro River, Babacomari River, and Turkey Creek are considered areas of high biological diversity.

Approximately nine miles northeast of the proposed T1 route, the Babacomari River converges with the San Pedro River, a major migratory bird flyway. Within one mile of the proposed T1 route, two raptor species have been documented as nesting and roosting along the Babacomari River - the Northern gray hawk (*Asturina nitida maxima)*, listed as an Arizona Wildlife of Special Concern, and Swainson's hawk (*Buteo swainsonii*), a Bureau of Land Management Sensitive Species (Nelson, 2009).

Vegetation in the project area is typical of Semidesert grassland community in the Warm-Temperate Grassland subdivision (Brown, 1994). Dominant overstory species along the proposed route were predominantly velvet mesquite (*Prosopis velutina)*, soaptree yucca (*Yucca elata)*, and oak trees (*Quercus* sp.) within the upland areas. Vegetation within the wetland areas consisted of mature Fremont's cottonwood (*Populus fremontii)*, Arizona ash (*Fraxinus velutina)*, and willows (*Salix* sp.). Construction of the T1 route of any other alternative route that is ultimately selected for construction will create ground disturbance. Plants in the general area that could be impacted include velvet mesquite and native grasses. However, regardless of the transmission line ultimately constructed, it is anticipated that only a few trees will be removed and most vegetative clearing will consist of limb pruning.

The San Rafael Valley is located in southern Arizona along the International Boundary about 75 miles southeast of Tucson. It is bounded on the east by the Huachuca Mountains and on the west by the Patagonia Mountains. Elevations in the San Rafael Valley area range from over 8,400 feet above mean sea level in the Huachuca Mountains to less than 4,620 feet above mean sea level at the International Boundary. The Valley contains a surface-water divide that separates the drainage into two watersheds, the Santa Cruz River and San Pedro River. The majority of the Valley is drained by the Santa Cruz River which flows south into Mexico, then flows north into Arizona near Nogales. The Santa Cruz River enters the Tucson Active Management Area at the point where it crosses the International Boundary ADWR 2009).

A small area in eastern San Rafael Valley drains south into the Mexican portion of the San Pedro River watershed. The San Pedro River flows north and crosses the International Boundary into the United States about 30 miles east of the San Rafael Valley (ADWR, 2009).

Portions of the Patagonia-Santa Rita Linkage and Tumacacori-Santa Rita Linkage wildlife corridors are located within the San Rafael Valley (Corridor Design, 2009). The latter corridor encompasses Cienega Creek and Sonoita Creek. These two linkages are home to far-ranging mammals such as black bear (*Ursus americanus*), mountain lion (*Puma concolor*), jaguar (*Panthera onca*), ocelot (*Leopardis pardalis*), and Mexican gray wolf (*Canis lupus baileyi*). These animals move long distances to gain access to suitable foraging or breeding sites, and benefit significantly from corridors that link large areas of habitat (Turner et al., 1995). Other mammal species that occur within these linkages and require movement to different parts of their range include badger (*Taxidea taxus*), coues' white-tailed deer (*Odocoileus virginianus couesi*), and mule deer (*Odocoileus hemionus*) (Corridor Design, 2009). Approximately 4.5 miles of the western portion of proposed transmission line crosses through these two corridors.

The valley is renowned for its wintering raptors. According to the Southeastern Arizona Bird Observatory, it is not uncommon to see over 100 birds of prey, sometimes up to12 species within a day's drive. Regularly seen raptors include: ferruginous hawk (*Buteo regalis*), great horned owl (*Bubo virginianus*), northern harrier (*Circus cyaneus*), Harris's Hawk (*Parabuteo unicinctus*), prairie falcon (*Falco mexicanus*), bald and golden eagles (*Haliaeetus leucocephalus* and *Aquila chrysaetos*), and a rainbow of subspecies and color morphs of red-tailed hawk (*Buteo jamaicensis*).

Potential Impacts

The potential for the proposed T1 route to impact migrations paths and movement of wildlife within the wildlife corridors was considered. There have been other recent evaluations of existing bridges, underpasses, overpasses, and culverts along highways as potential structures for animals to cross (Beier et al, 2008). Results of these evaluations were that housing and residential developments, major fences, habitat fragmentation and artificial night lighting can impede animal movement. Construction and operation of the proposed transmission line does not require additional roads, fencing, barriers, or artificial night lights that would affect wildlife movement. Based on both on consideration of the related studies and professional judgment, we do not believe that the proposed transmission line will affect wildlife species that utilize the Patagonia – Santa Rita wildlife corridor or Tumacacori – Santa Rita wildlife corridor.

Raptors are protected under the U.S. Migratory Bird Treaty Act (MBTA) of 1918 (16 USC 703-7 12). The area is a major flyway for several species that breed and winter in the valley. Raptors are drawn to transmission power poles because they offer a high place to perch, roost, nest, and hunt. However, the large wing spans of raptors make them vulnerable to injury by bridging phase conductors. Inclement weather creates an additional safety hazard because strong winds can move the power lines and the birds, so the likelihood of a bird touching a live wire and being electrocuted increases. Large species and immature raptors are most at risk.

The proposed T1 route also has the potential to increase predation of songbirds and other sensitive species by raptors and Corvid species (i.e., ravens, crows and magpies); especially in areas where few elevated perches exist. Towers may increase hunting efficiency (e.g., greater chance of prey detection and attack success) of avian predators because the elevated perches provide increased visibility of the surrounding area (Craighead and Craighead, 1956; Worley, 1984; Sonerud, 1992; APLIC, 1996; Leyhe and Ritchison, 2004).

The proposed T1 route also has the potential to impact grassland habitat because habitat will be removed by the construction of the line. However, impact should be minimal because a permanent ROWroad will not be installed, the footprint of the individual poles will be small, and disturbed areas will be reseeded with native grasses. In addition, the amount of grassland habitat to be disturbed is minimal compared to the availability of grassland habitat surrounding the project area.

Recommended Mitigation

With the successful implementation of the following mitigation measures, it is not expected that that construction of the proposed T1 route or any of the other transmission alternatives routes being considered in the general area would have a significant impact to biological resources or special status species. The mitigation measures identified below are independent of those which may have already been proposed by SSVEC. Therefore, mitigation measures provided herein may be the same as or similar to those already proposed or normally implemented as a part of SSVEC operations.

» Install raptor-proof structures on all existing and new transmission poles.

» Install appropriate perch-deterrents that target avian species known to exist in the area. Any perch-deterrent design considered should be evaluated for effectiveness under experimental settings before installation (Lammers, 2007). Insulate electrical lines. This can increase the safety for members of the cat family, raccoons and other wildlife whose curiosity and foraging habits draw them to climb power poles and other electrical facilities.

» Use covered wire for all new pole-mounted electrical equipment.

» Avoid impacting ephemeral washes that flow into Waters of the US, specifically tributaries of the Babacomari River, such as Turkey Creek.

- Limit the grading of undisturbed lands so as not to impact potential habitat for sensitive biological resources.
- Limit the location of staging areas to already disturbed areas. Staging areas should be located outside of riparian habitat, regardless if the area is disturbed.
- Avoid construction near the Babacomari River and Turkey Creek during spring months when raptors and migratory passerines are breeding.
- Restore degraded and disturbed construction areas (including staging areas) by re-seeding with a native plant seed mix. To limit the impact to native vegetation, the AGFD Heritage Data Management System includes recommendations that all degraded and disturbed lands be restored to their natural state (i.e., reseed with a native grass seed mix).

Emissions & Noise

The only options that materially increase emission are distributed generation options utilizing fossil fuel and electric space heating conversion. Also, energy storage may either increase or decrease emission depending on the on and off-peak marginal generation that is operating during charge and discharge cycles. Because of energy storage charging efficiency (typically 80 to 90 percent) and the potential for off-peak to burn fossil fuels (e.g., coal at the margin) versus natural or oil on peak, net emissions can increase.

Diesel generators without noise abatement systems can create site boundary noise of up to 100 decibels (db), well above the 50 db to 70 db allowable levels. Noise abatement would be required if diesel generators are installed at Sonoita. Options include sound attenuating enclosures or barriers, exhaust silencers, vibration isolation, and cooling air attenuation; or a combination of the above. In addition, sound attenuation increase with distance, with sound decreasing by about 6 db for every doubling of distance from the generator. The cost of the generator and site improvements are increased to cover the cost of sound abatement systems. Typically, an acoustic engineering firm (or offered by large equipment suppliers) to determine the optimal solution for a specific site.

Emissions Output – Distributed Generation Options

Table 15 lists expected DG emissions for the diesel generator option the level of emissions over 10-year intervals. The data conforms to application requirements outlined in the Arizona Department of Environmental Quality (ADEQ) Air Quality permit application process for diesel generators rated about 600 horsepower. The hours for each interval are based on the minimum run hours needed to meet capacity targets (as opposed to an assumption the generators would run all hours of the year).

Table 15: DG Fossil Fuel Emissions Projections (Diesel)

Pollutant (a)	Maximum Capacity (b) (horsepower)	Emission Factor (c) (pounds per hour)	Emissions (b×c) (pounds per hour)	Emissions (2010) Hours = 36 (tons/year)	Emissions (2019) Hours = 430 (tons/year)	Emissions (2029) Hours = 1789 (tons/year)
Carbon Monoxide	2682	0.0055	14.8	0.27	3.19	13.25
Nitrogen Oxide	2682	0.024	64.4	1.18	13.91	57.83
Sulfur Oxide	2682	0.00647	17.4	0.32	3.75	15.59
Volatile Organic Carbon	2682	0.000705	1.9	0.03	0.41	1.70
Particulate Matter	2682	0.0007	1.9	0.03	0.41	1.69

Source: http://www.azdeq.gov/environ/air/permits/class.html

Construction Impacts for Transmission Alternatives

Construction of a transmission line and substation, regardless of the alternative ultimately selected, would result in temporary and short-term construction related air emissions. Emissions during construction would be caused by exhaust from construction equipment, delivery vehicles and worker travel as well as fugitive dust from windblown erosion and the movement of vehicles on the construction site. Temporary construction emission levels are not quantified in this report. Prior to any construction activities, construction emissions levels should be quantified to confirm that they are below threshold levels imposed by applicable regulatory agencies.

Mitigation measures that could be used to minimize dust emissions during construction could include (but are not limited to):

- » Using low emitting diesel engines and ultra-low diesel fuel;
- » Regular preventive maintenance; and
- » Various fugitive dust mitigation measures (examples include water or chemical dust suppression, limiting traffic speeds, replanting vegetation in disturbed areas).

Renewable & Distributed Generation Options

Renewable & Distributed Generation Supply Alternative (R5) involves the use of Diesel Generation on the Sonoita Substation Site. The diesel generation could involve the use of multiple trailer or ground mounted diesel units burning low-sulfur distillate oil, or natural gas depending on the availability of local gas supply.

The Air Quality Division of the ADEQ issues air quality permits to industries and facilities that emit regulated pollutants to ensure that these emissions do not harm public health or cause significant deterioration in areas that presently have clean air. If the combined generator capacity) in Horsepower (HP) of all generators located at a facility is greater than 3,000 HP, then a project is not eligible for coverage under the ADEQ General Permit and must instead obtain an Individual Permit.

The proposed diesel generators would be housed within sound retardant enclosures; however no noise analysis or background noise study was conducted as part of this report. Additional analysis may need to be completed to ensure that noise generated by the diesel generators meets applicable Santa Cruz County noise requirements.

Electromagnetic Fields

Operating power lines, such as the energized components of electrical motors, home wiring, lighting, and all other electrical appliances, produce EMF, also commonly referred to as electromagnetic field. Electric fields around transmission lines are produced by electrical charges on the energized conductor. Electric field strength is directly proportional to the line's voltage; that is, increased voltage produces a stronger electric field. At a given distance from the transmission line conductor, the electric field is inversely proportional to the distance from the conductors, so that the electric field strength declines as the distance from the conductor increases. The strength of the electric field is measured in units of kilovolts per meter (kV/m). The electric field around a transmission line remains steady and is not affected by the common daily and seasonal fluctuations in usage of electricity by customers.

Magnetic fields around transmission lines are produced by the level of current flow through the conductors, measured in terms of amperes. The magnetic field strength is also directly proportional to the current; that is, increased amperes produce a stronger magnetic field. The magnetic field is inversely proportional to the distance from the conductors, and thus, like the electric field, the magnetic field strength declines as the distance from the conductor increases. Magnetic fields are expressed in units of milligauss (mG). The amperes and, therefore the magnetic field around a transmission line, fluctuate daily and seasonally as the usage of electricity varies.

EMF Research and Applicable Regulations

Considerable research has been conducted over the last 30 years on the possible biological effects and human health effects from EMF. This research has produced many studies that offer no uniform conclusions about whether long-term exposure to EMF is harmful or not.

No federal regulations have been established specifying environmental limits on the strengths of EMF from power lines. However, the federal government continues to conduct and encourage research necessary for an appropriate policy on EMF. While several states (including Florida and New York) have opted for design-driven regulations that ensuring that fields from new lines are generally similar to those from existing lines, other states, including Arizona have chosen not to specify maximum acceptable levels of EMF.

EMF Levels for Feasible Supply Alternatives

EMF levels for each of the feasible alternatives was determined and compared among key supply alternatives. Table 16 summarizes electric and magnetic field levels for three alternatives for the 2009 actual and 2029 projected peak load. The 69kV option produced the lowest EMF levels due to the lower phase currents compared to the existing line or lower voltage supply alternatives

Table 16: EMF Levels

EMF Summary at 2009 Peak Load and 2029 Forecasted Peak Load
Study Cases: V-7 Feeder without system Upgrades
Proposed transmission Line (Single Circuit Segment)
Proposed Transmission Line (Double Circuit Segment w/ V-7 Under Build)

Distance from the center of Structure (Perpendicular to the Line)	V-7 Feeder with Existing		69-kV Proposed Sub-Transmission Line Single Circuit Segment		V-7 Feeder/ Proposed Sub-Transmission Line Double Circuit Segment	
	2009 Peak Load	2029 Forecasted Load	2010 Peak Load	2029 Forecasted Load	2011 Peak Load	2029 Forecasted Load
Electric Field kV/m						
30ft	0.08	0.08	0.25	0.25	0.13	0.13
0	0.04	0.04	0.28	0.28	0.09	0.09
30ft ‡	0.06	0.06	0.22	0.22	0.06	0.06
Magnetic Field mG						
30ft	17.3	27.5	2.1	2.6	4.1	5.1
0	23.0	36.8	3.6	4.5	5.8	7.1
30ft ‡	13.0	22.3	2.2	2.8	4.1	5.1

‡ 30 ft distance in the opposite direction as the original 30 ft assessment

The above estimates are comparable, or in some cases below readings encountered in residences, where readings of 2 mG to 10 mG are produced by normal household appliances and wiring. Some appliances and household articles that operate sporadically or have occasional use such as microwaves and electric blankets can produce EMF that exceeds over 100 mG depending on the location of occupants.

Public Health Studies

Studies completed over a decade ago indicated the possibility of a correlation between electric line location and cancer. However, these studies showed a relatively weak correlation with many inconsistencies and questionable epidemiological methods. Among other deficiencies, the earlier studies indicated low EMF levels would produce higher cancer rates than lines with higher EMF levels; other studies showed minimal or negative correlation. Subsequent studies by independent experts have failed to demonstrate a direct correlation. Notably, the EMF levels produced by in-home appliances and low voltage electrical wiring often produces higher EMF levels than higher voltages distribution lines (which are usually located distance from residential premises).

State and national health agencies have not produced findings that support a conclusion that power lines present a public health hazard. Some state commissions and utilities have adopted a **"prudence avoidance"** approach, where utilities are advised to locate lines away from schools and heavily populated areas, where practicable. Other techniques for reducing EMF include frequent transposing of phase conductors, and increasing line height. Some have advised utilities to locate lines underground; however, underground lines require supplemental shielding to avoid increasing EMF levels since the cables, although buried, typically would be closer to residences and walkways with attendant higher EMF levels.

Other Environmental Issues

General Land & Permit Issues

SSVEC has an existing grant of easement for those portions of the proposed T1 route that cross the Ranch property. The grant is confidential between the subject parties and was not reviewed as part of this assessment. In addition and as discussed elsewhere in this report, SSVEC also has prescriptive rights through other portions of the general area for their existing distribution system. Regardless of the Transmission Supply Alternative that may be ultimately constructed, SSVEC would be required to obtain additional easements across public and private ROWs. An evaluation of the land ownership and the cost of additional easements was not conducted as part of this assessment. The status of obtaining other required easements in the general area is not known.

SSVCEC currently owns the currently vacant Sonoita and Buchanan sites (Attachment 1). Both sites have been considered for the construction of a substation. SSVEC recently reconsidered plans to develop a substation on the residentially zoned Buchanan site in lieu of building the substation on the commercially zoned Sonoita Site.

A number of permits could be required for construction of a transmission line in the general area. Depending on the route ultimately selected, these permits or authorizations could potentially include:

» Arizona State Lands Department - for crossing state land
» ADEQ, Air Division – for temporary construction impacts
» ADOT – for highway crossings
» Santa Cruz and Cochise County – for road crossings
» BLM – for crossing of the LCNCA

The requirements of each permit were not individually analyzed.

Permits and regulatory issues associated with Renewable & Distributed Generation Supply Alternative R5: Diesel Generation are discussed above in the Emissions/Noise Section.

Summary

The V-7 feeder is a very long circuit that is nearing or at capacity limits. It requires a significant number of regulators operating in tandem to maintain voltages within acceptable limits. Reliability is below that of other SSVEC feeders, but not unusually low, as SSVEC has implemented effective reliability improvement measures; however, the number of momentary interruptions appears to be high, in large part because of the very long lines. There is evidence the feeder may be experiencing other voltage anomalies that require resolution. In summary, the V-7 feeder cannot accommodate material increases in load without overloads or unacceptable voltage impacts, or both. Immediate action is necessary to address V-7 capacity and performance issues.

Several alternatives are feasible to resolve capacity and performance issues from a technical perspective. Most transmission options are technically viable, except for use of **TEP's** 46kV line to serve V-7 load, which appears to have insufficient capacity to serve incremental SSVEC load. The transmission supply options provide the highest level of firm capability compared to other feasible options, as the availability of new transmission lines tend to be higher than distributed generation options. Distributed generation options must be carefully maintained and complex control strategies, communication systems would be needed to ensure the units operate when needed.

The investigation of environmental issues indicates the new 69kV line along new and existing ROWs along the Ranch has the greatest impact of the options considered. If the 69kV line and new substation at Sonoita are built as previously proposed by SSVEC, modest mitigation efforts are needed to address biological, cultural, and archeological issues. The visual impact of a new line is the most significant, and efforts should be made by SSVEC to minimize visual impact if the line is constructed. These would include low-profile line design, selection of construction materials that blend with the landscape.

Most renewable energy options, including wind and solar photovoltaic, did not provide sufficient coincident peak load reduction to be feasible – the V-7 feeder peak occurs during cold winter mornings when the sun is low on the horizon. Concentrated solar power could provide a solution, but would be very expensive and have potentially undesirable visual impacts; it also requires significant land, which may be difficult to obtain in quantities sufficient to construct devices large enough to reduce peak demand. The other renewable energy options provide minimal voltage support, and do not improve power quality and reliability. Energy storage systems show much promise and efforts are underway on a national scale to advance the technology and reduce cost, but are still in the early stages of development. Storage also would require complex monitoring and control schemes to ensure sufficient storage was available and dispatched in a manner that will reduce loads over the full duration of the daily peak.

The lowest cost alternative is the targeted conversion of customer space heating systems, followed by the installation of oil or gas-fired diesel generators in Sonoita. However, there are clear trade-offs and concerns with the lower cost options. For targeted fuel conversions, the number of eligible customers and level of incentive needed to ensure sufficient participation levels has not been established. Such a program would need to be expedited, as the V-7 feeder has reached capacity limits. Further, the conversion program would only reduce feeder loading – voltage regulation and power quality issues would need to be addressed to ensure customers receive a level of service comparable to other feeders on SSVEC's system.

Other options that would have environmental impacts is the installation of generators at Sonoita and the conversion of existing electric space heating units to alternate fuels. If the amount of generation installed were to exceed state thresholds, an air quality permit likely would be needed. The EMF levels associated with existing lines versus options considered indicate each of the proposed upgrades or load management options will likely produce lower EMF levels than existing facilities. The absence of EMF standards does not enable a determination as to which alternatives are preferred from an EMF standpoint.

The preferred alternative based on feeder performance and firm capacity requirements is the construction of new 69kV line along the Ranch where SSVEC has easement rights.

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Attachment 1: Proposed Routing & Locations of Supply Alternatives

Navigant Consulting, Inc.
December 2009

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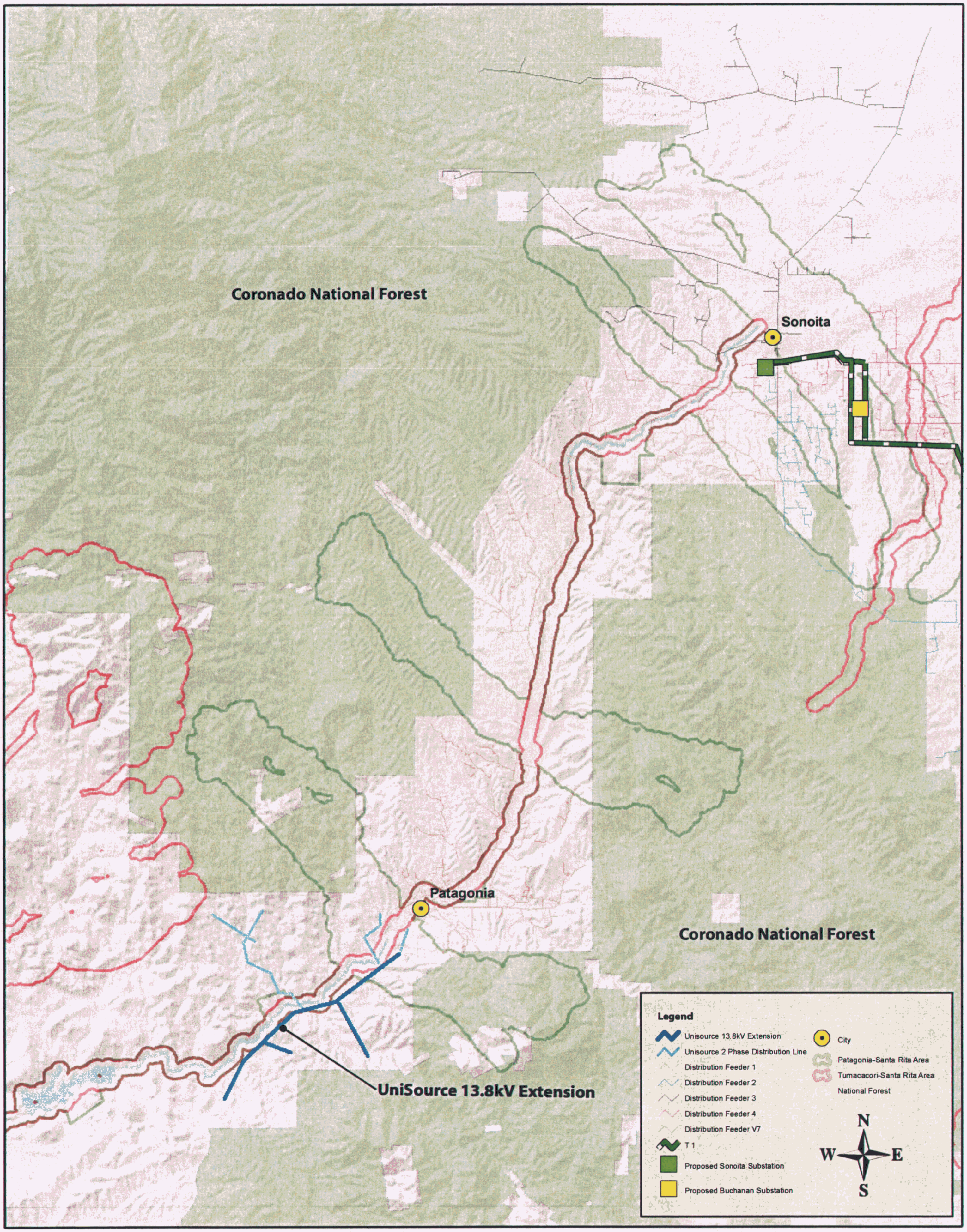
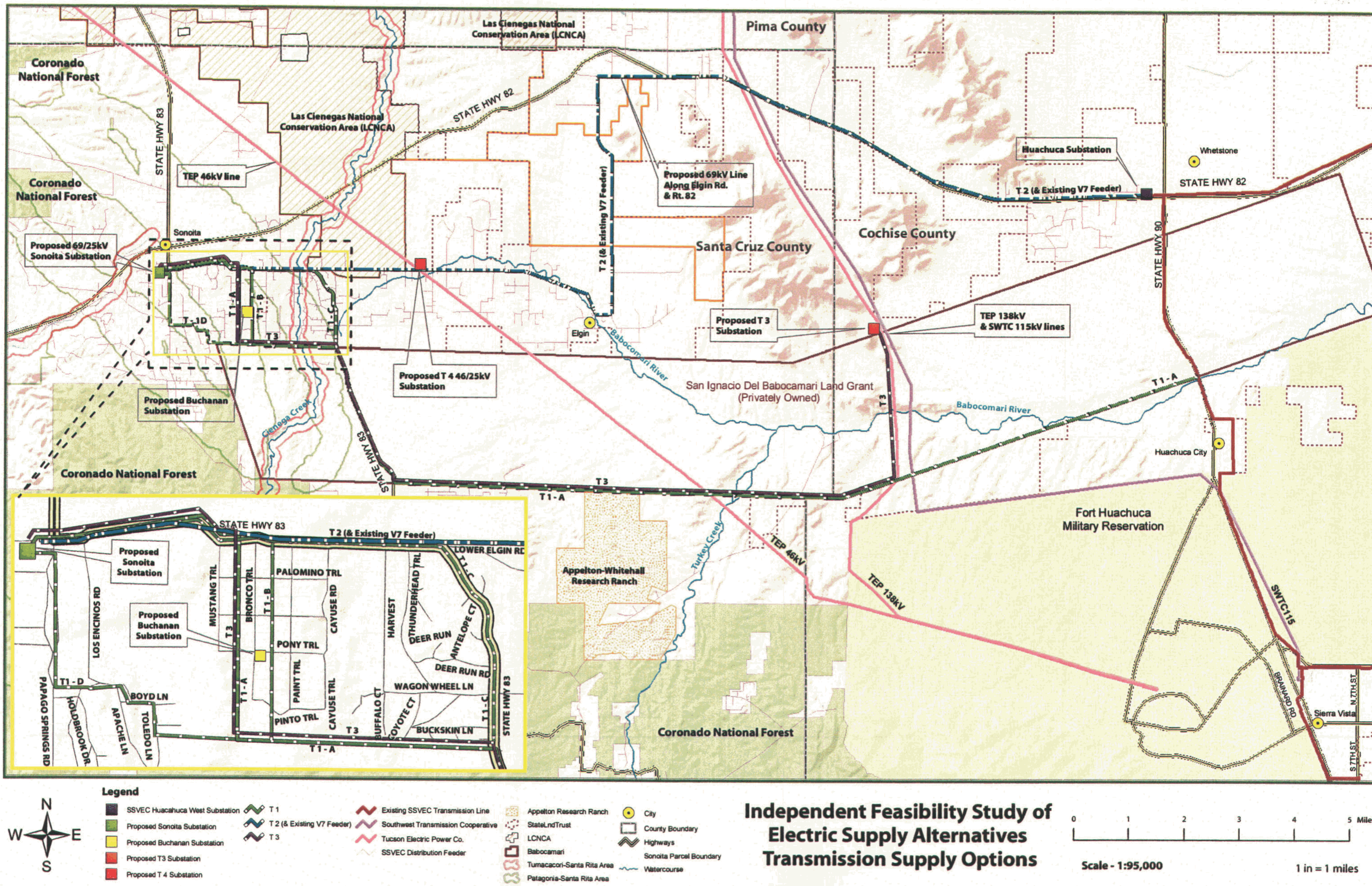
December 2009

Independent Feasibility Study of Electric Supply Alternatives - Transmission Supply Options





Independent Feasibility Study of Electric Supply Alternatives Transmission Supply Options

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Attachment 2: Summary of Technically Feasible Supply Alternatives

Category	Transmission Supply
Description of Solution	**Option T1**: Construct New 69 kilovolt (kV) Line & Sonoita substation along the San Ignacio Del Babocomari Ranch ROW (Original SSVEC proposal). Tap 69kV SSVEC transmission line south of Whetstone; construct about 25 miles of new 69kV along southern border and along State Route (SR) R 82. Single pole, vertical construction with single-circuit construction along most of the ROW. Alternatives considered include four options for routing line through Sonoita Hills subdivision. (T1-A, T1-B, T1-C and T1-D in Attachment 1).
Project or Solution Cost	Approximately $14 million.
Length of Time Needed to Implement the Solution	Approximately 12 - 18 months for design, equipment procurement and construction.
Length of Time Option Provides a Solution for Deficiencies	30 years (or longer).
Advantages of Proposed Solution	» Provides highest level of firm capacity over 20 years » Solves most, if not all current V-7 deficiencies » Provides greatest improvement on voltage and reliability performance » May provide a solution to V-7 voltage anomalies » Reduces losses to lowest level of all solutions » Most robust option to meet unexpected changes in load » Sonoita substation in ideal location to unload and reconfigure existing feeders » Existing ROW can be used to route 69kV line Relatively minor biological and cultural impacts with cost-effective mitigation available » Right-of-way is adjacent to existing telecommunication ROW » Major sections of line not visible to public
Disadvantages of Proposed Solution	» High construction costs compared to other options » Sections of line on **ROW's** that are visible to customers (and where lines presently do not exist)

Category	Transmission Supply
Description of Solution	**Option T2**: Construct New 69kV Line & Sonoita Substation. Tap 69kV SSVEC transmission line at Sonoita Substation; construct about 25 miles of new 69/25kV double circuit line along southern border and along Route 82. Single pole, vertical construction with double-circuit construction along the entire route.
Project or Solution Cost	Approximately $19 million.
Length of Time Needed to Implement the Solution	Approximately 16 - 24 months for design, equipment procurement and construction.
Length of Time Option Provides a Solution for Deficiencies	30 years (or longer).
Advantages of Proposed Solution	» Provides highest level of firm capacity over 20 years » Solves most, if not all current V-7 deficiencies (same as T1) » Provides greatest improvement on voltage and reliability performance (same as T1) » May provide a solution to V-7 voltage anomalies » Reduces losses to lowest level of all solutions (same as T1) » Most robust option to meet unexpected changes in load (same as T1) » Sonoita substation in ideal location to unload and reconfigure existing feeders (same as T1) » Relatively minor biological and cultural impacts with cost-effective mitigation available
Disadvantages of Proposed Solution	» Highest construction costs compared to other options » Need to obtain numerous new easements at potentially high cost and lengthy delays if condemnation is required » All sections of line on ROW's that are visible to customers » Construction challenges: line workers may need to work line hot » Lower reliability than T1 due to common mode outages

Category	Electric Storage Heating
Description of Solution	**Option DS2:** Aggressively pursue conversion of existing electric space heating for residential and commercial customers served by the V-7 feeder to electric storage heating. Customers would be offered incentives to replace existing space heating systems with new storage units. SSVEC would apply existing or develop new time-of-use (TOU) rates as an incentive for customers to convert existing systems. The storage units would charge during off-peak late evening and early morning hours. A minimum of 4 to 6kW per household or business would be required to justify conversion.
Project or Solution Cost	Approximately $2.5 million over 20 years.
Length of Time Needed to Implement the Solution	Approximately 12 - 18 months for appliance survey, program development and marketing, and initial customer sign-up.
Length of Time Option Provides a Solution for Deficiencies	Unknown until appliance survey is completed and customer participation level is determined.
Advantages of Proposed Solution	» Lowest cost of all solutions » Potentially avoids new construction for many years
Disadvantages of Proposed Solution	» Number of eligible heating customers unknown, including number of customers with heat pumps » Willingness of customers to participate at penetration levels high enough to meet capacity and performance requirements highly uncertain » Performance and reliability will continue to degrade to unacceptable levels if customer participation is low » New transmission may be needed if program results are lower than anticipated » Regulatory approval may be needed to authorize program incentives and TOU rates » Storage turn-on and turn-off intervals need to be carefully cycled to avoid high shoulder peaks » High penetration of electric storage may create shoulder of off-hour peaks » Length of shut-down hours may be unreasonably long as V-7 loads grow to higher levels » Off-peak losses increase due to simultaneous charging of storage units

Category	Electric Heating Fuel Conversion
Description of Solution	**Option DS4**: Aggressively pursue conversion of existing electric space heating for residential and commercial customers served by the V-7 feeder to use alternate fuels. Customers would be offered incentives to replace existing space heating systems with modular propane or kerosene systems. SSVEC would offset the cost of conversion as an incentive for customers to convert existing systems. A minimum of 4 to 6kW per household or business would be required to justify conversion.
Project or Solution Cost	Approximately $2.5 million over 20 years.
Length of Time Needed to Implement the Solution	Approximately 12 - 18 months for appliance survey, program development and marketing, and initial customer sign-up.
Length of Time Option Provides a Solution for Deficiencies	Unknown until appliance survey is completed and customer participation level is determined.
Advantages of Proposed Solution	» Lowest cost of all solutions (Same as DS2) » Potentially avoids new construction for many years
Disadvantages of Proposed Solution	» Number of eligible heating customers unknown, including number of customers with heat pumps » Willingness of customers to participate at penetration levels high enough to meet capacity and performance requirements highly uncertain » Performance and reliability will continue to degrade to unacceptable levels if customer participation is low » New transmission may be needed if program results are lower than anticipated » Burning propane or kerosene will create local fossil fuel emissions » Current high fuel cost provides minimal savings compared to average retail electric rates » Customers may override systems and use electric heating for reasons of cost or convenience

Category	Distributed Generation - Diesel
Description of Solution	**Option R5**: Install 2-1000kW or 4-500kW trailer or ground-mounted diesel generating units at the Sonoita substation site. Interconnect to adjacent 24.5kV distribution lines. Site improvements include fuel storage and handling systems, impenetrable berm or oil retention facility, screening and noise abatement. Also, step-up transformer and protective devices would be needed. After 10 to 15 years, increase site generation by 2000kW for a total of 4000 kW. Include SCADA and communication controls to enable remote operation by control center personnel.
Project or Solution Cost	Approximately $5.8 million over 20 years.
Length of Time Needed to Implement the Solution	Approximately 6 - 12 months depending on length of air quality permitting process
Length of Time Option Provides a Solution for Deficiencies	Up to 20 years, provided generation is permitted and allowed to operate up to 2000 hours in year 20
Advantages of Proposed Solution	» Low capital or lease cost » Sonoita site available to accommodate generation » Potentially avoids new line construction for many years
Disadvantages of Proposed Solution	» Uncertainty of air quality (or other state/local) permit requirements and operating limitations » Less reliability firm capacity than transmission options » SSVEC personnel not trained to operate and maintain fossil fuel generation » Does not materially improve feeder reliability and limited voltage support » Uncertainty as to whether unit output will reduce purchase power demand charges » Subject to fuel cost increases » Creates local fossil fuel emissions & noise » Operating hours increase significantly in later years » Minimal loss improvement in earlier years

Comparison of Feasible Supply Alternatives

Description of Solution	Solution Cost	Length of Time Needed to Implement the Solution	Length of Time Option Provides a Solution	Advantages of Proposed Solution	Disadvantages of Proposed Solution
Option T1: Construct New 69 kilovolt (kV) Line & Sonoita substation along the San Ignacio Del Babocomari Ranch, and new 69/25kV substation at Sonoita site	$14 Million	Approximately 12 - 18 months for design, equipment procurement and construction	30 years (or longer)	• Provides highest level of firm capacity over 20 years • Provides greatest improvement for voltage and reliability performance • Lowest losses of all solutions	• High construction costs compared to other options • New sections of line on some sections of ROW's are visible to customers
Option T2: Construct New 69kV Line & Sonoita Substation. Tap 69kV SSVEC transmission line at Huachuca West Substation; construct about 25 miles of new 69/25kV double circuit line along Route 82 and Elgin Road	$19 million	Approximately 16 - 24 months for design, equipment procurement and construction	30 years (or longer)	• Provides highest level of firm capacity over 20 years • Provides greatest improvement for voltage and reliability performance • Lowest losses of all solutions	• Highest construction costs compared to other options • Need to obtain numerous new & costly easements • All sections of line on ROW's are visible to customers
Option DS2: Convert electric space heating for residential and commercial customers. Customers would be offered incentives to replace existing space heating systems with new storage units.	$2.5 million	Approximately 12 - 18 months for appliance survey, program development and marketing, and initial customer sign-up	Unknown until appliance survey is completed and customer participation level is determined	• Lowest cost of all solutions • Potentially avoids new construction for many years	• Number of eligible heating customers unknown • Customer willingness to participate is uncertain • Performance and reliability will continue to degrade to if customer participation is low
Option DS4: Convert electric space heating for residential and commercial customers to use alternate fuels. Customers would be offered incentives to replace existing space heating systems with propane or kerosene units.	$2.5 million	Approximately 12 - 18 months for appliance survey, program development and marketing, and initial customer sign-up	Unknown until appliance survey is completed and customer participation level is determined	• Lowest cost of all solutions • Potentially avoids new construction for many years	• Number of eligible heating customers unknown • Customer willingness to participate is uncertain • Performance and reliability will continue to degrade to if customer participation is low
Option R5: Install 2-1000kW or 4-500kW diesel generating units at the Sonoita substation site. Interconnect to 24.9kV distribution lines. Includes fuel storage and handling systems, oil retention facility, screening and noise abatement.	$5.8 million	Approximately 6 - 12 months depending on length of air quality permitting process	Up to 20 years, provided generation is allowed to operate up to 2000 hours in year 20	• Low capital or lease cost • Sonoita site available to accommodate generation • Potentially avoids new line construction for many years	• Uncertainty of air quality or other permit requirements • Less reliable firm capacity than transmission options • Does not materially improve feeder reliability and voltage

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Attachment 3: Photographs

Photo 1: View from Lower Elgin Road showing typical landscape character of project area.

Photo 2: View from Babocomari Ranch.

Photo 3: View from SR-83 in Sonoita with hillside rural residences.

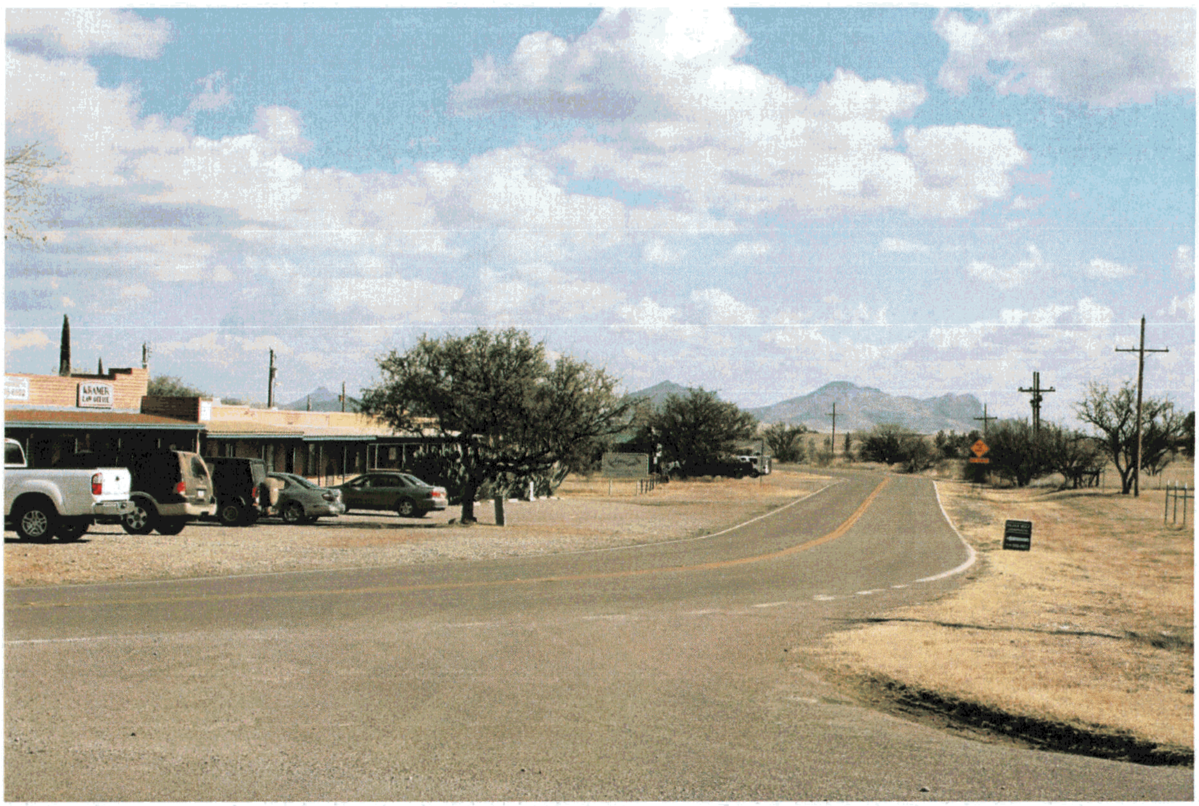

Photo 4: View along SR-83 with commercial development in Sonoita.

Photo 5: View from Broncho Trail near Pony Trail with rural residences near the proposed and undeveloped Buchanan Substation site.

Photo 6: View along SR-90 in Huachuca City.

Photo 7: View of Babacomari Ranch with rural residence.

Photo 8: View from Babacomari Ranch with existing transmission lines and wood support structures.

Photo 9: View toward new Sonoita Substation site from Old Sonoita Highway at SR-83.

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Attachment 4: Previously Recorded Archaeological Sites and Studies in the General Area

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December 2009

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December 2009

Summary of previously recorded sites within a half mile radius of the proposed T1 route:

AZ EE:6:43(ASM) - This site consists of historic road segments dating to pre-1958 and paralleling State Route 82. Stone (1992-153.ASM) states that it is considered to be potentially eligible for inclusion in the NRHP; however, later annotations in the report mention that it is no longer considered a site. Railey and Yost (2003-910.ASM) identified the road segments within their project area and agreed with earlier recommendations that it is potentially eligible for the NRHP under Criterion D (that have yielded, or may be likely to yield, information important in prehistory or history).

AZ EE:7:176(ASM) - The site consists of segments of an historic road that represent parts of the original State Route 90 which was built prior to 1940 and reconstructed in 1960s. The road segments have been recommended as potentially eligible for listing on the NRHP (Wright 1992-268.ASM). Sites AZ EE:7:175 and AZ EE:7:176 appear to represent segments of the same historic era road grade.

AZ EE:7:261(ASM) – This is a prehistoric site with architectural remains. It includes cobble alignments, approximately 15 house pit depressions, pottery, groundstone and flaked stone artifacts. Portions of the site were excavated in 1996 by Allen Denoyer prior to the land owners' development of the parcel (Heckman and Denoyer 1996). There is no information regarding the NRHP eligibility of the site.

AZ EE:7:263(ASM) – The site consists of three small rock features of unknown age and function. They represent small rock piles without associated artifacts which could be either prehistoric or historic in origin. Kayser and Serrano (1999-337.ASM) recommended that they be considered potentially eligible for the NRHP under Criterion D pending further study.

AZ EE:7:1(ASM) – This site was recorded in 1937 and described as a village (Babacomari Village) with probable shallow pit houses, with abundant ceramics (Gila polychrome, red-on-brown plain ware and an unidentified polychrome) and groundstone. There is no information regarding the NRHP eligibility of the site.

AZ EE:7:2(ASM) – This site was recorded in 1937 and described as a village with a walled enclosure (possible corral of adobe) with fairly abundant pottery (Gila Polychrome and red-on-brown) and flaked stone artifacts. There is no information regarding the NRHP eligibility of the site.

AZ EE:7:3(ASM) – This site recorded in 1937 is described as being covered with overburden and likely secondarily deposited. Pottery is not very abundant, but shells and a possible bison jaw were noted in the cutbank. There is no information regarding the NRHP eligibility of the site.

AZ EE:7:4(ASM) – This site recorded in 1937 is described as a pottery sherd area (Gila Polychrome, red ware and brown plainware) with groundstone (manos and boulder mortar) and flaked stone artifacts (projectile point fragments, scrapers and an axe or hammer fragment). Rock alignment within the site suggested possible rooms. There is no information regarding the NRHP eligibility of the site.

AZ EE:7:7(ASM) – This site represents the remains of Old Fort Wallen which contains both historic and prehistoric components. Two mounds were noted which exhibited traces of adobe walls and from which several prehistoric pottery sherds were collected (Gila Polychrome, red-on-brown and other prehistoric types). Piles of rocks were interpreted as graves of soldiers from the historic fortification. There is no information regarding the NRHP eligibility of the site.

AZ EE:7:342(ASM) – This site consists of a prehistoric artifact scatter with no obvious features. Twenty-eight artifacts were noted including a plainware pottery sherd, two manos and a metate fragment and flaked stone. The site has been disturbed by mechanical cuts and push piles, but the presence of artifacts in the disturbed areas suggested possible buried deposits. The site was recommended as eligible for the NRHP under Criterion D (Purcell 2006:991.ASM).

AZ EE:7:343(ASM) – This site consists of a sparse prehistoric and historic artifact scatter. The prehistoric artifacts include 14 pieces of flaked stone (a core, biface, scraper and debitage) and a plainware pottery sherd. The historic material includes 13 ceramic fragments, 12 glass fragments and 59 pieces of metal which likely represents materials from the early 1900s to present. The site was recommended as not eligible to the NRHP under any criteria as the initial recording is likely to have collected all the information that the site has to offer (Purcell 2006:991.ASM)

Summary of previous archaeological studies within a half mile radius of the proposed T1 route:

1986-87.ASM
This 11 acre survey was conducted by Lyle Stone for the Arizona Department of Transportation (ADOT) in advance of a proposed rest room facility project adjacent to State Route 82. No sites were recorded although two isolates of flaked stone were noted.

1988-79.ASM
This project consisted of a 2.5 acre survey by John Douglas for a property development. No sites were identified but isolates consisting of eight flakes and two cores were noted.

1992-153.ASM
This five mile linear survey was conducted by Lyle Stone for the ADOT for a highway maintenance project. Two sites and four isolates were identified including Sites AZ EE:6:43 and AZ EE:6:44 both of which are within the proposed project area and were considered to be potentially eligible for inclusion in the NRHP pending evaluation. As previously noted, the report was later annotated to state that Site AZ EE:6:43 is no longer considered a site.

1992-268.ASM
This linear survey of 24 miles of the State Route 90 right-of-way was conducted by Thomas Wright for the ADOT in advance of a highway widening project. Six archaeological sites were identified including one within the proposed project area, Site AZ EE:7:175, which was considered potentially NRHP eligible.

1993-74.ASM
This project consists of a linear survey of 12.3 miles along State Route 82 conducted by Lyle Stone for the ADOT for a proposed pavement preservation undertaking. Two historic sites were identified but not within the proposed project area.

2001-39.ASM
This 96 acre survey was conducted by Laurens Hammack for FNF Construction, Inc. for the expansion of an existing materials source and related access roads. No resources were identified during the survey.

2003-910.ASM
TRC Environmental Corporation conducted a 489 mile long linear survey for a proposed fiber optic line across Arizona and New Mexico. A total of 95 sites were identified along the survey within Arizona including two sites in the proposed project area (AZ EE:4:43 and AZ EE:6:43) both of which were recommended as eligible or potentially eligible for the NRHP.

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Attachment 5: Arizona Game and Fish Department's (AGFD) and U.S. Fish and Wildlife Service (USFWS) - Species List

Navigant Consulting, Inc.
December 2009

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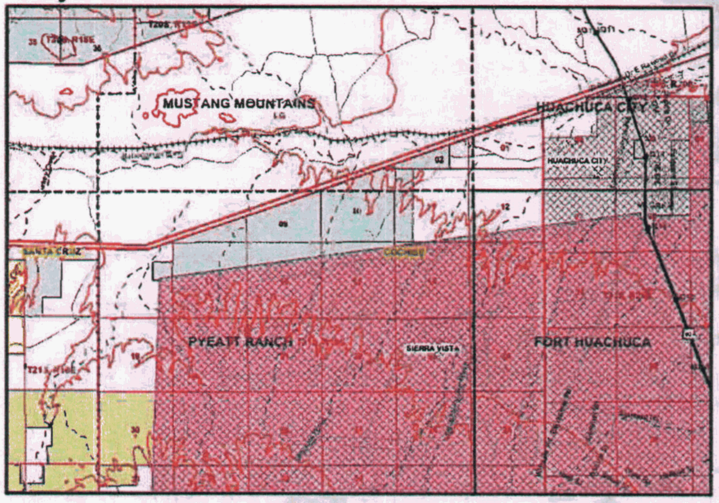
December 2009

Arizona's On-line Environmental Review Tool
Search ID: 20091120010672
Project Name: Sonoita Reliability Project-east
Date: 11/20/2009 9:50:43 AM

Project Location



Project Name: Sonoita Reliability Project-east
Submitted By: Robin Llewellyn
On behalf of: CONSULTING
Project Search ID: 20091120010672
Date: 11/20/2009 9:50:37 AM
Project Category: Energy Storage/Production/Transfer,Energy Transfer,Power line/electric line (new)
Project Coordinates (UTM Zone 12-NAD 83): 554630.024, 3499076.389 meter
Project Length: 14017.526 meter
County: COCHISE,SANTA CRUZ
USGS 7.5 Minute Quadrangle ID: 1890
Quadrangle Name: MUSTANG MOUNTAINS
Project locality is currently being scoped

Location Accuracy Disclaimer

Project locations are assumed to be both precise and accurate for the purposes of environmental review. The creator/owner of the Project Review Receipt is solely responsible for the project location and thus the correctness of the Project Review Receipt content.

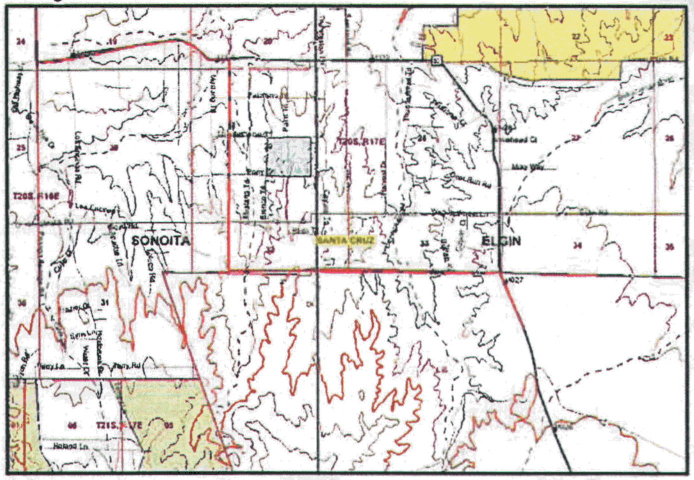
The Department appreciates the opportunity to provide in-depth comments and project review when additional information or environmental documentation becomes available.

Special Status Species Occurrences/Critical Habitat/Tribal Lands within 3 miles of Project Vicinity:

Name	Common Name	ESA	USFS	BLM	State
Agosia chrysogaster chrysogaster	Gila Longfin Dace	SC		S	
Ammodramus bairdii	Baird's Sparrow	SC		S	WSC
Anthus spragueii	Sprague's Pipit				WSC
Asclepias uncialis	Greene Milkweed	SC	S		
Buteo nitidus maxima	Northern Gray Hawk	SC	S	S	WSC
Buteo swainsoni	Swainson's Hawk			S	
CH for Gila intermedia	Designated Critical Habitat for Gila chub				
Catostomus clarkii	Desert Sucker	SC		S	
Catostomus insignis	Sonora Sucker	SC		S	
Coccyzus americanus	Yellow-billed Cuckoo (Western U.S. DPS)	C			WSC
Cyprinodon macularius	Desert Pupfish	LE			WSC
Erigeron arisolius			S		
Gila intermedia	Gila Chub	LE	S		WSC
Hedeoma dentatum	Mock-pennyroyal		S		
Lilaeopsis schaffneriana var. recurva	Huachuca Water Umbel	LE			HS
Lithobates chiricahuensis	Chiricahua Leopard Frog	LT	S		WSC
Myotis velifer	Cave Myotis	SC			
Pectis imberbis	Beardless Chinch Weed	SC	S		
Rana yavapaiensis	Lowland Leopard Frog	SC	S	S	WSC
Spiranthes delitescens	Madrean Ladies'-tresses	LE			HS
Sympetrum signiferum	Spot-winged Meadowhawk		S		
Talinum humile	Pinos Altos Flame Flower	SC	S		SR
Thamnophis eques megalops	Brown Gartersnake	C	S		WSC

Arizona's On-line Environmental Review Tool
Search ID: 20091118010624
Project Name: Sonoita Reliability Project
Date: 11/18/2009 11:29:27 AM

Project Location



Project Name: Sonoita Reliability Project
Submitted By: Robin Llewellyn
On behalf of: CONSULTING
Project Search ID: 20091118010624
Date: 11/18/2009 11:29:20 AM
Project Category: Energy Storage/Production/Transfer,Energy Transfer,Power line/electric line (new)
Project Coordinates (UTM Zone 12-NAD 83): 531859.006, 3507310.531 meter
Project Length: 7742.726 meter
County: SANTA CRUZ
USGS 7.5 Minute Quadrangle ID: 1894
Quadrangle Name: SONOITA
Project locality is not anticipated to change

Location Accuracy Disclaimer

Project locations are assumed to be both precise and accurate for the purposes of environmental review. The creator/owner of the Project Review Receipt is solely responsible for the project location and thus the correctness of the Project Review Receipt content.

The Department appreciates the opportunity to provide in-depth comments and project review when additional information or environmental documentation becomes available.

Special Status Species Occurrences/Critical Habitat/Tribal Lands within 3 miles of Project Vicinity:

Name	Common Name	ESA	USFS	BLM	State
Ammodramus bairdii	Baird's Sparrow	SC		S	WSC
Anthus spragueii	Sprague's Pipit				WSC
Asclepias uncialis	Greene Milkweed	SC	S		
CH for Lilaeopsis schaffneriana var. recurva	Designated Critical Habitat for Huachuca water umbel				
Choeronycteris mexicana	Mexican Long-tongued Bat	SC		S	WSC
Hedeoma dentatum	Mock-pennyroyal		S		
Heterotheca rutteri	Huachuca Golden Aster	SC	S	S	
Lampropeltis getula nigrita	Western Black Kingsnake		S		
Lilaeopsis schaffneriana var. recurva	Huachuca Water Umbel	LE			HS
Patagonia - Santa Rita Linkage Design	Wildlife Corridor				
Santa Rita - Tumacacori Linkage Design	Wildlife Corridor				
Sigmodon ochrognathus	Yellow-nosed Cotton Rat	SC			
Talinum humile	Pinos Altos Flame Flower	SC	S		SR
Talinum marginatum	Tepic Flame Flower	SC	S		SR

Cochise County

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Beautiful shiner	*Cyprinella formosa*	Threatened	Small (2.5 inches) shiny minnow, very similar to red shiner. Males colorful during breeding (yellow-orange or orange on caudal and lower fins, bluish body).	Cochise	< 4,500 ft	Small to medium sized streams and ponds with sand, gravel, and rock bottoms.	Virtually extirpated in the United States, with the exception of a few populations on San Bernardino National Wildlife Refuge. Same critical habitat as Yaqui Chub and Catfish (see 49 FR 34490, 08-31-84).
Canelo Hills ladies' tresses	*Spiranthes delitescens*	Endangered	Slender, erect member of the orchid family (Orchidaceae). Flower stalk 20 inches tall, may contain 40 white flowers spirally arranged on the flowering stalk.	Cochise, Santa Cruz	~ 5,000 ft	Finely grained, highly organic, saturated soils of cienegas.	Found in the San Pedro watershed. Potential habitat occurs in Sonora, Mexico, but no populations have been found.
Chiricahua leopard frog	*Lithobates [Rana] chiricahuensis*	Threatened	Cream colored tubercles (spots) on a dark background on the rear of the thigh, dorsolateral folds that are interrupted and deflected medially, and a call given out of water distinguish this spotted frog from other *leopard frogs*.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, Navajo, Pima, Santa Cruz, Yavapai	3,300-8,900 ft	Streams, rivers, backwaters, ponds, and stock tanks that are mostly free from introduced fish, crayfish, and bullfrogs.	Require permanent or nearly permanent water sources. Populations north of the Gila River may be a closely-related, but distinct, undescribed species. A special rule allows take of frogs due to operation and maintenance of livestock tanks on State and private lands.
Cochise pincushion cactus	*Coryphantha robbinsorum*	Threatened	A small unbranched cactus with no central spines and 11-17 white radial spines. The bell-shaped flowers are borne on the ends of tubercles (protrusions). Flowers: bell shaped, pale yellow-green. Fruits: orange-red to red.	Cochise	> 4,200 ft	Semidesert grassland with small shrubs, agave, other cacti, and grama grass.	Grows on gray limestone hills. Species also occurs in Sonora, Mexico

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Desert pupfish	*Cyprinodon macularius*	Endangered	Small (2 inches) smoothly rounded body shape with narrow vertical bars on the sides. Breeding males blue on head and sides with yellow on tail. Females and juveniles tan to olive colored back and silvery sides.	Cochise, Graham, Maricopa, Pima, Pinal, Santa Cruz, Yavapai	< 4,000 ft	Shallow springs, small streams, and marshes. Tolerates saline and warm water.	Two subspecies are recognized: Desert Pupfish (C.m. macularis) and Quitobaquito Pupfish (C.m. eremus). Critical habitat includes Quitobaquito Springs, Pima County, portions of San Felipe Creek, Carrizo Wash, and Fish Creek Wash, Imperial County, California.
Gila chub	*Gila intermedia*	Endangered	Deep compressed body, flat head. Dark olive-gray color above, silver sides. Endemic to Gila River Basin.	Cochise, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, Yavapai	2,000-5,500 ft	Pools, springs, cienegas, and streams.	Found on multiple private lands, including the Nature Conservancy and the Audubon Society. Also occurs on Federal and state lands and in Sonora, Mexico. Critical habitat occurs in Cochise, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai counties.
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	Endangered	Small (2 inches), guppy-like, live bearing, lacks dark spots on its fins. Breeding males are jet black with yellow fins.	Cochise, Gila, Graham, Maricopa, Pima, Santa Cruz, Yavapai	< 4,500 ft	Small streams, springs, and cienegas vegetated shallows.	Species historically also occurred in backwaters of large rivers but is currently isolated to small streams and springs.
Huachuca water umbel	*Lilaeopsis schaffneriana ssp. recurva*	Endangered	Herbaceous, semi-aquatic perennial in the parsley family (Umbelliferae) with slender erect, hollow, leaves that grow from the nodes of creeping rhizomes. Flower: 3 to 10 flowered umbels arise from root nodes.	Cochise, Pima, Santa Cruz	3,500-6,500 ft	Cienegas, perennial low gradient streams, wetlands.	Species also occurs in adjacent Sonora, Mexico, west of the continental divide. Critical habitat in Cochise and Santa Cruz counties (64 FR 37441, July 12, 1999).
Jaguar	*Panthera onca*	Endangered	Largest species of cat native to Southwest. Muscular, with relatively short, massive limbs, and a deep-chested body. Usually cinnamon-buff in color with many black spots. Weights ranges from 90-300 lbs.	Cochise, Santa Cruz, Pima	1,600-9,000 ft	Found in Sonoran desertscrub up through subalpine conifer forest.	Also occurs in New Mexico. A Jaguar conservation team is being formed that is being led by Arizona and New Mexico state entities along with private organizations.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	Endangered	Elongated muzzle, small leaf nose, and long tongue. Yellowish brown or gray above and cinnamon brown below. Tail minute and appears to be lacking. Easily disturbed.	Cochise, Gila, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz, Yuma	1,600-11,500 ft	Desert scrub habitat with agave and columnar cacti present as food plants.	Day roosts in caves and abandoned tunnels. Forages at night on nectar, pollen, and fruit of paniculate agaves and columnar cacti. This species is migratory and is present in Arizona usually from April to September and south of the border the remainder of the year.
Loach minnow	*Tiaroga cobitis*	Threatened	Small (<3 inches) slender, elongated fish, olive colored with dirty white spots at the base of the dorsal and caudal fins. Breeding males vivid red on mouth and base of fins.	Apache, Cochise, Gila, Graham, Greenlee, Navajo, Pinal	< 8,000 ft	Benthic species of small to large perennial streams with swift shallow water over cobble and gravel. Recurrent flooding and natural hydrograph important.	Presently found in Aravaipa Creek, Deer Creek, Turkey Creek, Blue River, Campbell Blue Creek, San Francisco River, Eagle Creek, North Fork of the East Fork Black River, and White River in Arizona, and Dry Blue Creek, Pace Creek, Frieborn Creek, the Tularosa River, West Fork Gila River, and the mainstem upper Gila River in New Mexico. Populations have been recently reintroduced in Hot Springs and Redfield canyons in Cochise and Graham counties; Fossil Creek in Gila County; and Bonita Creek in Graham County Arizona. Critical habitat (72 FR 13356-13422, March 21, 2007) found in Apache, Graham, Greenlee, and Pinal counties, Arizona, as well as portions of the Blue River, San Francisco River, Tularosa River, Negrito Creek, Pace Creek, Dry Blue Creek, Frieborn Creek, Whitewater Creek, Gila River, and its West, Middle, and East Forks in Catron, Grant, and Hidalgo counties in New Mexico.
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Medium sized with dark eyes and no ear tufts. Brownish and heavily spotted with white or beige.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai	4,100-9,000 ft	Nests in canyons and dense forests with multi-layered foliage structure.	Generally nest in older forests of mixed conifer or ponderosa pine/gambel oak type, in canyons, and use variety of habitats for foraging. Sites with cool microclimates appear to be of importance or are preferred. Critical habitat was finalized on August 31, 2004 (69 FR 53182) in Arizona in Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Navajo, Pima, Pinal, Santa Cruz, and Yavapai counties.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
New Mexico ridge-nosed rattlesnake	*Crotalus willardi obscurus*	Threatened	Small 12-24 inches, secretive grayish-brown with a distinct ridge on the end of the snout. The dorsal surface has obscure, irregularly spaced white crossbars edged with brown (not a bold pattern).	Cochise	5,000-6,600 ft	Primarily canyon bottoms in pine-oak communities.	The subspecies has been documented in the Peloncillo Mountains in Arizona. There are only three known records from Arizona. Also occurs in Animas Mountains of New Mexico and Sierra San Luis in Sonora/Chihuahua.
Northern aplomado falcon	*Falco femoralis septentrionalis*	Endangered	Rufus underparts, gray back, long banded tail, and a distinct black and white facial pattern. Smaller than peregrine falcon but larger than a kestrel. Breeds between March and June.	Currently extirpated from AZ with unconfirmed sightings occasionally reported in Cochise County.	3,500-9,000 ft	Grassland and savannah	Non-essential experimental population designated in Arizona and New Mexico in 2006. Species formerly nested in southwestern U.S., now rarely occurs. Good habitat has low ground cover and mesquite or yucca for nesting platforms. Pesticide use in Mexico had endangered this species but DDT use is now banned there. Reintroductions are occurring in New Mexico and Texas. One confirmed sighting in AZ occurred in recent years.
Ocelot	*Leopardus (=Felis) pardalis*	Endangered	Medium-sized spotted cat that is yellowish with black streaks and stripes running from front to back. Tail is spotted and about 1/2 the length of head and body. Face is less heavily streaked than the back and sides.	Cochise, Pima, Santa Cruz	< 8,000 ft	Desert scrub in Arizona. Humid tropical and sub-tropical forests, and savannahs in areas south of the U.S.	May persist in partly-cleared forests, second-growth woodland, and abandoned cultivated areas reverted to brush. Universal component is presence of dense cover. Unconfirmed reports of individuals in the southern part of the State continue to be received.
Sonoran tiger salamander	*Ambystoma mavortium stebbinsi*	Endangered	Large, light-colored blotches or reticulations on a dark background. Metamorphosed individuals are 1.8 to 5.9 inches in snout-vent length. Aquatic larvae are uniform dark colored with plume-like gills and developed tail fins.	Cochise, Santa Cruz	4,000-6,300 ft	Stock tanks and impounded cienegas; rodent burrows, rotted logs, and other moist cover sites.	Populations occur within the headwaters of the Santa Cruz and San Pedro Rivers. These include San Rafael Valley and in the foothills of the east slope of the Patagonia and Huachuca Mountains and Fort Huachuca.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	Small passerine (about 6 inches) grayish-green back and wings, whitish throat, light olive-gray breast and pale yellowish belly. Two wingbars visible. Eye-ring faint or absent.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	< 8,500 ft	Cottonwood/willow and tamarisk vegetation communities along rivers and streams.	Migratory riparian-obligate species that occupies breeding habitat from late April to September. Distribution within its range is restricted to riparian corridors. Difficult to distinguish from other members of the Empidonax complex by sight alone. Training seminar required for those conducting flycatcher surveys. Critical habitat was finalized on October 19, 2005 (50 CFR 60886). In Arizona there are critical habitat segments in Apache, Cochise, Gila, Graham, Greenlee, Maricopa, Mohave, Pima, Pinal, and Yavapai counties.
Spikedace	*Meda fulgida*	Threatened	Small (<3 inches) slim fish with silvery sides and "spine" on dorsal fin. Breeding males are a brassy golden color.	Cochise, Gila, Graham, Greenlee, Pinal, Yavapai	< 6,000 ft	Medium to large perennial streams with moderate to swift velocity waters over cobble and gravel substrate. Recurrent flooding and natural hydrograph important to withstand invading exotic species.	Presently found in Aravaipa Creek, Eagle Creek, Verde River, and the Gila River from the San Pedro River to Ashurst-Hayden Dam in Arizona, and the Gila River and its East and West Forks in New Mexico. Populations have been recently reintroduced in Hot Springs and Redfield canyons in Cochise and Graham counties; Fossil Creek in Gila County; and Bonita Creek in Graham County Arizona. Critical habitat (72 FR 13356-13422, March 21, 2007) in Graham, Greenlee, Pinal, and Yavapai counties in Arizona, and in Catron, Grant, and Hidalgo counties in New Mexico.
Yaqui catfish	*Ictalurus pricei*	Threatened	Similar to channel catfish (Ictalurus punctatus) except anal fin base is shorter and the distal margin of the anal fin is broadly rounded with 23-25 soft rays. Body usually profusely speckled.	Cochise	4,000-5,000 ft	Moderate to large streams with slow current over sand and rock bottoms.	Critical habitat includes all aquatic habitats on San Bernadino National Wildlife Refuge.
Yaqui chub	*Gila purpurea*	Endangered	Medium sized minnow (<6 inches) dark colored, lighter below. Dark triangular caudal spot.	Cochise	4,000-6,000 ft	Deep pools of small streams near undercut banks and debris; pools associated with springheads, and artificial ponds.	Introduced populations exist in Leslie Canyon, in San Bernardino National Wildlife Refuge, and ponds and mainstem of West Turkey Creek in the Chiricahua Mountains. Critical habitat includes all aquatic habitats on San Bernardino National Wildlife Refuge.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Yaqui topminnow	*Poeciliopsis occidentalis sonoriensis*	Endangered	Small (2 inches) guppy-like, live bearing fish (lacking dark spots on fins). Breeding males are jet black with yellow fins.	Cochise	< 4,500 ft	Small to moderate sized streams, springs, and cienegas. Generally found in shallow areas with aquatic vegetations or debris. Tolerates relatively high water temperature and low dissolved oxygen.	Natural and introduced populations occur on San Bernardino National Wildlife Refuge and an introduced population is found in Leslie Canyon. Populations also exist in Mexico.
Arizona treefrog (Huachuca/Canelo DPS)	*Hyla wrightorum*	Candidate	Small (1.8 inches in length) green frog; dark eye stripe extends past shoulder onto the sides of the body, may break into spots or dashes past shoulder, throat on males dusky green or tan; larger tadpoles golden brown above and below with mottled black tails.	Cochise, Santa Cruz	5,000-8,500 ft	Madrean oak woodlands, savannah, pine-oak woodlands, and mixed conifer forests.	Known from less than 20 localities in the Huachuca Mountains and adjacent Canelo Hills. Believed this population is geographically disjunct from the other known locality in the wetlands at Rancho Los Fresnos, Sonora, Mexico.
Huachuca springsnail	*Pyrgulopsis thompsoni*	Candidate	Very small (.06-.12 inches) conical shell. Identification must be verified by characteristics of reproductive organs.	Cochise, Santa Cruz	4,500-7,200 ft	Aquatic areas, small springs with vegetation and slow to moderate flow.	Individuals found on firm substances (roots, wood, and rocks). Other populations found on Fort Huachuca.
Lemmon fleabane	*Erigeron lemmonii*	Candidate	A prostrate perennial in the sunflower family. Stems and leaves are densely hairy. Flowers look like small delicate daisies, with white to light purple outer petals and yellow inner petals.	Cochise	1,500-6,000 ft	Grows in dense clumps in crevices, ledges, and boulders in canyon bottoms in pine-oak woodland.	Found only at one site on Fort Huachuca.
Northern Mexican Gartersnake	*Thamnophis eques megalops*	Candidate	Background color ranges from olive, olive-brown, to olive-gray. Body has three yellow or light colored stripes running down the length of the body, darker towards tail. Species distinguished from other native gartersnakes by the lateral stripes reaching the 3rd and 4th scale rows. Paired black spots extend along dorsolateral fields.	Apache, Cochise,Coconino, Gila, Graham, Navajo, Pima, Pinal, Santa Cruz, Yavapai	130-8,500 ft	Cienegas, stock tanks, large-river riparian woodlands and forests, streamside gallery forests.	Core population areas in the U.S. include mid/upper Verde River drainage, mid/lower Tonto Creek, and the San Rafael Valley and surrounding area. Status on tribal lands unknown. Distributed south into Mexico along the Sierra Madre Occidental and Mexican Plateau. Strongly associated with the presence of a native prey base including leopard frogs and native fish.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
San Bernardino springsnail	*Pyrgulopsis bernardina*	Candidate	Aquatic snail of family Hydrobiidae. Narrow-conic shell; height 1.3-1.7 mm; 3.25-4.0 whorls.	Cochise	3,806 ft	Springs with firm substrate composed of cobble, gravel, woody debris, and aquatic vegetation.	Distribution limited to Snail Spring on Slaughter Ranch in southeastern Arizona.
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate	Medium-sized bird with a slender, long-tailed profile, slightly down-curved bill that is blue-black with yellow on the lower half. Plumage is grayish-brown above and white below, with rufous primary flight feathers.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	< 6,500 ft	Large blocks of riparian woodlands (cottonwood, willow, or tamarisk galleries).	Neotropical migrant that winters primarily in South America and breeds primarily in the U.S. (but also in southern Canada and northern Mexico). As a migrant it is rarely detected; can occur outside of riparian areas. Cuckoos are found nesting statewide, mostly below 5,000 feet in central, western, and southeastern Arizona. Concern for cuckoos are primarily focused upon alterations to its nesting and foraging habitat. Nesting cuckoos are associated with relatively dense, wooded, streamside riparian habitat, with varying combinations of Fremont cottonwood, willow, velvet ash, Arizona walnut, mesquite, and tamarisk. Some cuckoos have also been detected nesting in velvet mesquite, netleaf hackberry, Arizona sycamore, Arizona alder, and some exotic neighborhood shade trees.
Ramsey Canyon leopard frog	*Rana subaquavocalis*	Conservation Agreement	Brown or green frog, 2.5 to 4 inches long; rear thigh pattern formed by small, raised cream-colored spots *on a dark background;* dorsolateral folds are interrupted posteriorly and deflected medially; relatively rough-skinned; knob-like terminal swellings on toes; stocky body proportions.	Cochise	4,924-6,000 ft	Aquatic systems, primarily ponds, in pine-oak and oak woodlands and semi-desert grasslands.	Known from six localities in canyons on the southeastern portion of the Huachuca Mountains (Ash, Miller, Carr, Ramsey, Brown, and Tinker). A Conservation *Agreement and Conservation* Assessment and Strategy was finalized in August 2007, which renews the former agreement that was signed in 1996.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
American peregrine falcon	*Falco pereginus anatum*	Delisted	A crow-sized falcon with slate blue-gray on the back and wings, and white on the underside; a black head with vertical "bandit's mask" pattern over the eyes; long pointed wings; and a long wailing call made during breeding. Very adept flyers and hunters, reaching diving speeds of 200 mph.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	3,500-9,000 ft	Areas with rocky, steep cliffs, primarily near water, where prey (primarily shorebirds, songbirds, and waterfowl) concentrations are high. Nests are found on ledges of cliffs, and sometimes on man-made structures such as office towers and bridge abutments.	Species recovered with over 1,650 breeding birds in the US and Canada.

Santa Cruz County

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Canelo Hills ladies' tresses	*Spiranthes delitescens*	Endangered	Slender, erect member of the orchid family (Orchidaceae). Flower stalk 20 inches tall, may contain 40 white flowers spirally arranged on the flowering stalk.	Cochise, Santa Cruz	~ 5,000 ft	Finely grained, highly organic, saturated soils of cienegas.	Found in the San Pedro watershed. Potential habitat occurs in Sonora, Mexico, but no populations have been found.
Chiricahua leopard frog	*Lithobates [Rana] chiricahuensis*	Threatened	Cream colored tubercles (spots) on a dark background on the rear of the thigh, dorsolateral folds that are interrupted and deflected medially, and a call given out of water distinguish this spotted frog from other leopard frogs.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, Navajo, Pima, Santa Cruz, Yavapai	3,300-8,900 ft	Streams, rivers, backwaters, ponds, and stock tanks that are mostly free from introduced fish, crayfish, and bullfrogs.	Require permanent or nearly permanent water sources. Populations north of the Gila River may be a closely-related, but distinct, undescribed species. A special rule allows take of frogs due to operation and maintenance of livestock tanks on State and private lands.
Desert pupfish	*Cyprinodon macularius*	Endangered	Small (2 inches) smoothly rounded body shape with narrow vertical bars on the sides. Breeding males blue on head and sides with yellow on tail. Females and juveniles tan to olive colored back and silvery sides.	Cochise, Graham, Maricopa, Pima, Pinal, Santa Cruz, Yavapai	< 4,000 ft	Shallow springs, small streams, and marshes. Tolerates saline and warm water.	Two subspecies are recognized: Desert Pupfish (C.m. macularis) and *Quitobaquito Pupfish* (*C.m. eremus*). Critical habitat includes Quitobaquito Springs, Pima County, portions of San Felipe Creek, Carrizo Wash, and Fish Creek Wash, Imperial County, California.
Gila chub	*Gila intermedia*	Endangered	Deep compressed body, flat head. Dark olive-gray color above, silver sides. Endemic to Gila River Basin.	Cochise, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, Yavapai	2,000-5,500 ft	Pools, springs, cienegas, and streams.	Found on multiple private lands, including the Nature Conservancy and the Audubon Society. Also occurs on Federal and state lands and in Sonora, Mexico. Critical habitat occurs in Cochise, Gila, Graham, Greenlee, Pima, Pinal, Santa Cruz, and Yavapai counties.
Gila topminnow	*Poeciliopsis occidentalis occidentalis*	Endangered	Small (2 inches), guppy-like, live bearing, lacks dark spots on its fins. Breeding males are jet black with yellow fins.	Cochise, Gila, Graham, Maricopa, Pima, Santa Cruz, Yavapai	< 4,500 ft	Small streams, springs, and cienegas vegetated shallows.	Species historically also occurred in backwaters of large rivers but is currently isolated to small streams and springs.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Huachuca water umbel	*Lilaeopsis schaffneriana ssp. recurva*	Endangered	Herbaceous, semi-aquatic perennial in the parsley family (Umbelliferae) with slender erect, hollow, leaves that grow from the nodes of creeping rhizomes. Flower: 3 to 10 flowered umbels arise from root nodes.	Cochise, Pima, Santa Cruz	3,500-6,500 ft	Cienegas, perennial low gradient streams, wetlands.	Species also occurs in adjacent Sonora, Mexico, west of the continental divide. Critical habitat in Cochise and Santa Cruz counties (64 FR 37441, July 12, 1999).
Jaguar	*Panthera onca*	Endangered	Largest species of cat native to Southwest. Muscular, with relatively short, massive limbs, and a deep-chested body. Usually cinnamon-buff in color with many black spots. Weights ranges from 90-300 lbs.	Cochise, Santa Cruz, Pima	1,600-9,000 ft	Found in Sonoran desertscrub up through subalpine conifer forest.	Also occurs in New Mexico. A Jaguar conservation team is being formed that is being led by Arizona and New Mexico state entities along with private organizations.
Lesser long-nosed bat	*Leptonycteris curasoae yerbabuenae*	Endangered	Elongated muzzle, small leaf nose, and long tongue. Yellowish brown or gray above and cinnamon brown below. Tail minute and appears to be lacking. Easily disturbed.	Cochise, Gila, Graham, Greenlee, Maricopa, Pima, Pinal, Santa Cruz, Yuma	1,600-11,500 ft	Desert scrub habitat with agave and columnar cacti present as food plants.	Day roosts in caves and abandoned tunnels. Forages at night on nectar, pollen, and fruit of paniculate agaves and columnar cacti. This species is migratory and is present in Arizona usually from April to September and south of the border the remainder of the year.
Mexican spotted owl	*Strix occidentalis lucida*	Threatened	Medium sized with dark eyes and no ear tufts. Brownish and heavily spotted with white or beige.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai	4,100-9,000 ft	Nests in canyons and dense forests with multi-layered foliage structure.	Generally nest in older forests of mixed conifer or ponderosa pine/gambel oak type, in canyons, and use variety of habitats for foraging. Sites with cool microclimates appear to be of importance or are preferred. Critical habitat was finalized on August 31, 2004 (69 FR 53182) in Arizona in Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Navajo, Pima, Pinal, Santa Cruz, and Yavapai counties.
Ocelot	*Leopardus (=Felis) pardalis*	Endangered	Medium-sized spotted cat that is yellowish with black streaks and stripes running from front to back. Tail is spotted and about 1/2 the length of head and body. Face is less heavily streaked than the back and sides.	Cochise, Pima, Santa Cruz	< 8,000 ft	Desert scrub in Arizona. Humid tropical and sub-tropical forests, and savannahs in areas south of the U.S.	May persist in partly-cleared forests, second-growth woodland, and abandoned cultivated areas reverted to brush. Universal component is presence of dense cover. Unconfirmed reports of individuals in the southern part of the State continue to be received.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Pima pineapple cactus	*Coryphantha scheeri var. robustispina*	Endangered	Hemispherical stems 4-7 inches tall 3-4 inches diameter. Central spine 1 inch long straw colored hooked surrounded by 6-15 radial spines. Flower: yellow, salmon, or rarely white narrow floral tube.	Pima, Santa Cruz	2,300-5,000 ft	Sonoran desertscrub or semi-desert grassland communities.	Occurs in alluvial valleys or on hillsides in rocky to sandy or silty soils. This species can be confused with juvenile barrel cactus (Ferocactus). However, the spines of the later are flattened, in contrast with the round cross-section of the Coryphanta spines. About 80-90% of individuals occur on state or private land.
Sonora chub	*Gila ditaenia*	Threatened	Minnow (<5 inches long) moderately chubby, dark-colored fish with two prominent black lateral bands on the sides and a dark oval spot at the base of the tail. Breeding males have red lower fins and a orange belly.	Santa Cruz	3,900 ft	Perennial and intermittent, small to moderate sized streams with boulders and cliffs.	Critical habitat includes Sycamore Creek (Santa Cruz County) and a 15 meter buffer from the U.S.- Mexico border to approximately 8 km upstream; Yank Spring; lowermost 2 km of Penasco Creek; and lowermost 0.4 km of an unnamed Sycamore Creek tributary. Species extends into Mexico (Altar and Magdalena rivers).
Sonoran tiger salamander	*Ambystoma mavortium stebbinsi*	Endangered	Large, light-colored blotches or reticulations on a dark background. Metamorphosed individuals are 1.8 to 5.9 inches in snout-vent length. Aquatic larvae are uniform dark colored with plume-like gills and developed tail fins.	Cochise, Santa Cruz	4,000-6,300 ft	Stock tanks and impounded cienegas; rodent burrows, rotted logs, and other moist cover sites.	Populations occur within the headwaters of the Santa Cruz and San Pedro Rivers. These include San Rafael Valley and in the foothills of the east slope of the Patagonia and Huachuca Mountains and Fort Huachuca.
Southwestern willow flycatcher	*Empidonax traillii extimus*	Endangered	Small passerine (about 6 inches) grayish-green back and wings, whitish throat, light olive-gray breast and pale yellowish belly. Two wingbars visible. Eye-ring faint or absent.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	< 8,500 ft	Cottonwood/willow and tamarisk vegetation communities along rivers and streams.	Migratory riparian-obligate species that occupies breeding habitat from late April to September. Distribution within its range is restricted to riparian corridors. Difficult to distinguish from other members of the Empidonax complex by sight alone. Training seminar required for those conducting flycatcher surveys. Critical habitat was finalized on October 19, 2005 (50 CFR 60886). In Arizona there are critical habitat segments in Apache, Cochise, Gila, Graham, Greenlee, Maricopa, Mohave, Pima, Pinal, and Yavapai counties.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Arizona treefrog (Huachuca/Canelo DPS)	*Hyla wrightorum*	Candidate	Small (1.8 inches in length) green frog; dark eye stripe extends past shoulder onto the sides of the body, may break into spots or dashes past shoulder, throat on males dusky green or tan; larger tadpoles golden brown above and below with mottled black tails.	Cochise, Santa Cruz	5,000-8,500 ft	Madrean oak woodlands, savannah, pine-oak woodlands, and mixed conifer forests.	Known from less than 20 localities in the Huachuca Mountains and adjacent Canelo Hills. Believed this population is geographically disjunct from the other known locality in the wetlands at Rancho Los Fresnos, Sonora, Mexico.
Huachuca springsnail	*Pyrgulopsis thompsoni*	Candidate	Very small (.06-.12 inches) conical shell. Identification must be verified by characteristics of reproductive organs.	Cochise, Santa Cruz	4,500-7,200 ft	Aquatic areas, small springs with vegetation and slow to moderate flow.	Individuals found on firm substances (roots, wood, and rocks). Other populations found on Fort Huachuca.
Northern Mexican Gartersnake	*Thamnophis eques megalops*	Candidate	Background color ranges from olive, olive-brown, to olive-gray. Body has three yellow or light colored stripes running down the length of the body, darker towards tail. Species distinguished from other native gartersnakes by the lateral stripes reaching the 3rd and 4th scale rows. Paired black spots extend along dorsolateral fields.	Apache, Cochise,Coconino, Gila, Graham, Navajo, Pima, Pinal, Santa Cruz, Yavapai	130-8,500 ft	Cienegas, stock tanks, large-river riparian woodlands and forests, streamside gallery forests.	Core population areas in the U.S. include mid/upper Verde River drainage, mid/lower Tonto Creek, and the San Rafael Valley and surrounding area. Status on tribal lands unknown. Distributed south into Mexico along the Sierra Madre Occidental and Mexican Plateau. Strongly associated with the presence of a native prey base including leopard frogs and native fish.
Stephan's riffle beetle	*Heterelmis stephani*	Candidate	Small aquatic beetle, typically less than 0.11 inches in total length.	Santa Cruz	5,100-6,600 ft	Free-flowing springs and seeps, commonly referred to as rheocrenes.	Current distribution is limited to Sylvester Spring. Historically known from Bog Springs, the type locality. Both springs located in Madera Canyon on the Coronado National Forest.

COMMON NAME	SCIENTIFIC NAME	STATUS	DESCRIPTION	COUNTY	ELEVATION	HABITAT	COMMENTS
Yellow-billed cuckoo	*Coccyzus americanus*	Candidate	Medium-sized bird with a slender, long-tailed profile, slightly down-curved bill that is blue-black with yellow on the lower half. Plumage is grayish-brown above and white below, with rufous primary flight feathers.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	< 6,500 ft	Large blocks of riparian woodlands (cottonwood, willow, or tamarisk galleries).	Neotropical migrant that winters primarily in South America and breeds primarily in the U.S. (but also in southern Canada and northern Mexico). As a migrant it is rarely detected; can occur outside of riparian areas. Cuckoos are found nesting statewide, mostly below 5,000 feet in central, western, and southeastern Arizona. Concern for cuckoos are primarily focused upon alterations to its nesting and foraging habitat. Nesting cuckoos are associated with relatively dense, wooded, streamside riparian habitat, with varying combinations of Fremont cottonwood, willow, velvet ash, Arizona walnut, mesquite, and tamarisk. Some cuckoos have also been detected nesting in velvet mesquite, netleaf hackberry, Arizona sycamore, Arizona alder, and some exotic neighborhood shade trees.
American peregrine falcon	*Falco pereginus anatum*	Delisted	A crow-sized falcon with slate blue-gray on the back and wings, and white on the underside; a black head with vertical "bandit's mask" pattern over the eyes; long pointed wings; and a long wailing call made during breeding. Very adept flyers and hunters, reaching diving speeds of 200 mph.	Apache, Cochise, Coconino, Gila, Graham, Greenlee, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, Yuma	3,500-9,000 ft	Areas with rocky, steep cliffs, primarily near water, where prey (primarily shorebirds, songbirds, and waterfowl) concentrations are high. Nests are found on ledges of cliffs, and sometimes on man-made structures such as office towers and bridge abutments.	Species recovered with over 1,650 breeding birds in the US and Canada.

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